DEC STD 265-0 Module Rework and Repair Standard Procedures

DOCUMENT IDENTIFIER: A-DS-EL00265-00-0000 Rev E, 23-Jul-1990

ABSTRACT: This Digital Manufacturing process standard establishes the standard module rework and repair methods and procedures to be used by Manufacturing and the Customer Services Module Repair Centers.

APPLICABILITY: Mandatory for all manufacturing organizations and Customer Services personnel engaged in module rework and repair activities.

STATUS: APPROVED 23-Jul-1990; use VTX SMC for current status.

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1 INTRODUCTION

1.1 PURPOSE

This standard establishes the methods and procedures required to rework and repair modules. The purpose of using these standard procedures is to maintain the reliability and workmanship of reworked or repaired modules equal to the quality of the original module.

1.2 SCOPE

The rework and repair procedures described or referenced in this standard apply to all modules that are intended for sale, or included in products intended for sale, by Digital Equipment Corporation. These procedures are intended to be applied in conjunction with any product-specific rework instructions that are issued as part of a module ECO.

In addition to DEC STD 265-0 and product-specific ECO instructions, the repair document *Suggested Guide Lines for Modification, Rework and Repair of Printed Boards and Assemblies* IPC-R-700C should be followed when repairing modules.

IPC-R-700C is a document written by the IPC for the sole purpose of documenting industry-accepted repair techniques. Because Leo Lambert from Manufacturing Process Engineering - Technical Resource Group (MPE/TRG) is a contributor to this document by representing Digital, Digital has the right to use IPC-R-700C in any Digital facility.

Copies of IPC-R-700C are available from:

Standards and Methods Control
NRO4/D4, DTN: 287-3724, JOKUR::SMC

The IPC-R-700C document has been assigned a Digital part number, EL-MF265-00, to facilitate ordering. When IPC updates the 700C repair document, new copies will be automatically sent to the users of DEC STD 265-0.

NOTE

If a repair topic is documented in both DEC STD 265-0 and IPC-R-700C, DEC STD 265-0 will take precedence.

In addition to this document and the IPC document referenced here, DEC STD 176 must also be used when evaluating whether a non-conforming PWB necessitates rework or repair. *DEC STD 176-1 Printed-Wiring Board Repair Criteria* provides a general overview of typical PWB repairs and lists many rules to follow when repairing a non-conforming PWB.

Care should be taken when reading DEC STD 176 so as not to confuse repair criteria for (bare) PWBs (in DEC STD 176) with module rework and repair criteria (in DEC STD 265) although the majority of rules in DEC STD 176 apply to modules as well. All repairs made to a module must conform to the workmanship standards identified in *DEC STD 116-0 Workmanship Standards Manual*.

If rules or procedures are unclear, please call the person responsible for this standard for further information or clarification.

1.3 RESPONSIBILITIES

1.3.1 Manufacturing

All manufacturing organizations and external vendors engaged in module rework and repair activities are required to follow the procedures in this standard.

1.3.2 Field Service Module Repair Centers

All Field Service personnel engaged in module rework and repair activities are required to follow the rework and repair procedures in this standard.

1.3.3 Module Process Management

This standard is controlled and maintained by Manufacturing Process Engineering - Technical Resource Group (MPE/TRG). For additional information, contact:

Steve Spaulding,
Manufacturing Process Engineering - Technical Resource Group (MPE/TRG)
TWO/C10, DTN: 247-2301, PARITY::SPAULDING

1.4 TOOL SELECTION

Throughout this document, various tools are recommended for performing repair operations. Heading 12 lists all recommended tools and corresponding vendors who supply them.

NOTE

The vendors mentioned are not necessarily the only sources for these tools. They are, however, the only vendors qualified by MPE/TRG. Other vendors may be added if their equipment is qualified and meets the criteria established by MPE/TRG.

1.5 OPERATOR SAFETY

Numerous chemicals, such as adhesives and solvents are recommended for use in repair operations throughout this document. All of these substances have been approved by Digital safety engineers. For more specific information regarding these chemicals, refer to Material Safety Data Sheets that should be available from either your plant safety engineer or nurse.

1.6 PART REVISION INDICATOR UPDATE

The part revision indicator shall be updated in accordance with the rework instructions provided with the ECO documentation.

DEC STD 012-0 Part Identification Standard defines the rules for part revision indicators. *DEC STD 140-0 Documentation, Data, and Release Requirements for Printed-Wiring Boards, Modules, and Backplanes - Introduction* provides instructions and examples of how DEC STD 012-0 rules apply to module ECOs. These rules preclude the use of CS (circuit schematic) revisions on new modules. However, for the many modules that have been produced using CS revision indicators, the following procedures for updating module revision indicators are valid.

2 GENERAL RULES FOR MODULE MARKING

If an old part is ECOd. it **must** comply with *DEC STD 012-0 Part Identification Standard*. Refer to DEC STD 012-0 for more information.

2.1 CS INDICATOR (OLDER MODULES)

When a printed-circuit board has a CS (circuit schematic) revision indicator, the indicator must be composed of the following characters (etched on Side 1).

CS*A B C D E F H J K L M N P R S

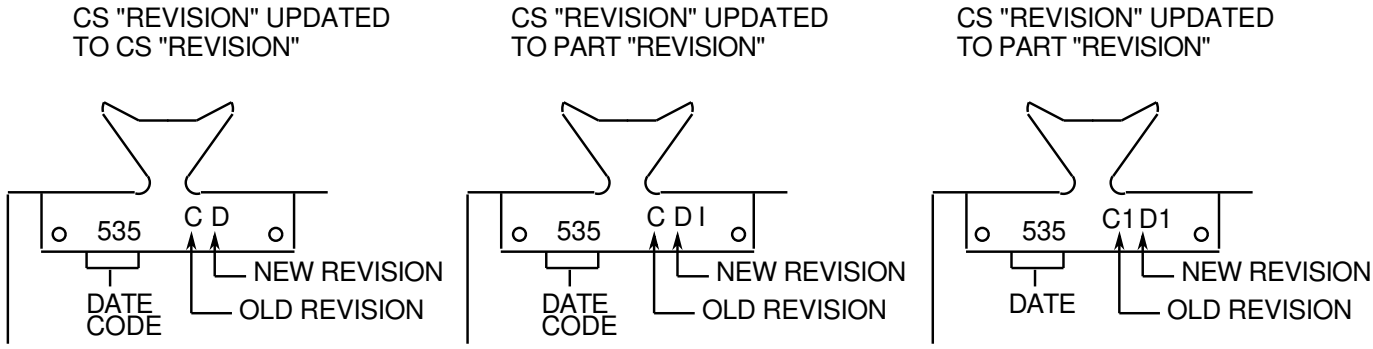
This revision indicator shall be updated in accordance with the rework instructions provided with the ECO documentation.

After a module has been reworked according to the ECO, remove the characters, from left-to-right, starting with the asterisk (*) as directed by the rework instructions. Do not remove any characters in an attempt to update the revision indicator if specific directions are not included in the rework instructions.

The characters can be removed by using an X-Acto knife or by applying heat with a soldering iron and lifting the etch from the board. The characters must be removed, not crossed out.

2.2 UPDATING MODULES WITH HANDLES

Figure 1: Module Handle Revision Marking



a. The part revision (CS revisions on modules where the part revision has not yet been implemented) shall be marked on the module handle on Side 2. The handle farthest to the left must have the marking (see Figure 1).

b. Only one handle per module needs to be marked with the revision. Be sure that the same handle that contains the previous part revision(s) is marked with the current part revision or that the previous part revision is rendered illegible.

c. All updating of part revisions (except by Field Service) will be permanently marked on the module handle. This can be done by using one of the following methods.

Use a metal stamp to impress the part revision into the handle or use a rubber stamp and permanent ink to apply the part revision onto the handle. The ink must not fade, smudge, or disappear when dry, and must resist normal solvents.

d. If Side 2 of a module handle will ultimately be covered, the part revision may be stamped on Side 1 using the requirements for updating modules without handles.

e. Part revisions stamped on the module handle shall begin with the revision at which the module was manufactured. Subsequent revisions shall appear showing the current revision and ECO history. Revisions shall not be cropped out. (See Figure 1.)

2.3 UPDATING MODULES WITHOUT HANDLES

a. The part revision shall be affixed in any convenient location on Side 1 (not in the contact finger area), provided they are not in a position where they will be covered by a connector or cable. The stamp should be made in the same location on all modules of a particular lot.

b. All updating of part revisions will be permanently marked on the module surface, using black indelible ink (or a color that can easily be seen) and a stamp pad. White indelible ink should be used on boards that are dark in color if the black ink will not be clearly visible.

c. If the stamp will ultimately be covered in final assembly, the part revision shall be stamped on Side 2.

2.4 REPAIR LABEL (BAR CODE)

DEC STD 047-1 Bar Code: Product and Shipping Carton/Container Labelling provides instructions and sample labels to properly identify the module number, part revision and repair history code on all modules returned for repair due to normal consumption or inoperative conditions.

The Repair Label is required in order to properly track the revision of the module. The Repair History Label is required because it will assist in determining the repair history of each module that is returned to the repair centers. Refer to DEC STD 047-1 for rules and requirements associated with bar coding labels.

3 GENERAL RULES FOR MODULE REPAIR AND REWORK

3.1 SOLDERING (GENERAL RULES)

All soldering irons are to be equipped with voltage suppresser (zero voltage switching) switches and grounded tips to ensure protection from electrostatic discharge (ESD) damage.

Soldering iron tip temperatures are to be in the range of 600 °F - 700 °F (316°C - 371°C). See Table 1 for recommended soldering irons.

Table 1 lists recommended soldering irons and tips for specific technology boards. If soldering irons other than those recommended are used, the tips for each application should be similar to the chisel tips listed here.

Table 1: Soldering Irons

Soldering Irons	MSL Fine Line	Standard Tips	Power Supplies
Ungar 9000	9012 (1/16 in.)	9015 (5/16 in.)	9016 (3/32 in.)
Weller EC2000 or EC4000	ETK (3/64 in.)	ETL (5/64 in.)	ETC (1/8 in.)
Hexacon 1001/1002	J201X, J206X (1/16 in.)	J202X (3/32 in.)	J101X, J301X (1/8 in.)
METCAL STSS-001 (1/32 in.)	STTC-025	STTC-037 (1/16 in.)	STT-C113 (1/8 in.)
Sta Temp		STTC-137 (1/16 in.)	

3.1.1 Hand-Soldering Procedure (General Procedure)

This procedure is to be followed in all hand-soldering operations.

1. Inspect all surfaces to be soldered (for example, component leads, PTHs) for any contaminants that may impair the formation of an acceptable solder joint. If contaminants are found, clean with approved solvents listed in subhead 3.2.
2. Tin the soldering iron with solder and wipe the tip on a damp sponge.
3. Re-tin the soldering iron tip. Carefully apply flux to the joint to be resoldered.
4. Apply the heated tip and solder to the junction to be soldered. Make sure solder flows around the junction. Heat should be applied for a maximum of three seconds. If an acceptable solder joint is not formed, allow the joint to cool for 15 seconds and repeat Steps 1 to 4.

3.1.2 No Soldering to Fine Line Etch

Soldering of wires or components to fine line etches (etch widths of 0.008 inch or less) is not allowed under any circumstances. Connections should be made at the nearest connected plated-through hole.

All wire or component additions to high-power circuitry (etches) are to be mechanically secure before soldering. For example, all leads or wires must pass through a drilled hole or wrap around an existing secure component. Refer to *DEC STD 119-0 Digital Product Safety - Introduction and General Requirements*.

a. Wires or component leads soldered directly to an etch or other component leads must have a minimum of 0.125 inch (3.17 mm) to a maximum of 0.25 inch (6.35 mm) wire/lead soldered.

b. Solid wire is preferred for soldering. If stranded wire is used, it must be pre-tinned to aid solderability and reduce the possibility of shorts.

c. Wire sizes used should correspond to the circuit width listed in Tables 4 and 5.

d. Wires and leads should lay flush and parallel on the etch to which they are being soldered.

e. Solder mask must be removed from the section of the etch to which the wire or lead is to be soldered.

3.2 CLEANING (GENERAL PROCEDURE)

Restrict the use of cleaning solvents to the area to be cleaned. These solvents can damage plastic module handles or other areas of the module.

The approved cleaning solvents to be used in the hand-cleaning operation are listed here.

a. Fluorinated solvents, such as Freon TP-35, TE-35, TMS-DuPont

b. Chlorinated solvents, such as 111-Trichloroethane or site-specified alternative, VG, NV

c. Solvent blend, such as D-Sol-F13.

CAUTION

Do not use trichloroethylene or any flammable solvents such as isopropyl or n-propyl alcohol.

Clean modules by brushing the fluxed area, preferably with a bristle brush, using the approved solvent. Use sufficient solvent to wash the flux off the edge of the modules.

CAUTION

Do not brush the solvent in the direction of plastic handles or paper labels.

NOTE

The only situation in which water soluble fluxes are to be used in hand soldering operations is in touch-up. Modules that will not be cleaned in an aqueous cleaner must be soldered using rosin fluxes and cleaned with approved solvents listed above. The preferred flux is Alpha 611 RMA.

3.2.1 Gold Finger Cleaning

Refer to *Printed Wiring Board (PWB) Gold Contact Cleaning Process*, EL-FS266-00.

4 THROUGH-HOLE COMPONENT REMOVAL (NON-PGA, NON-SMT)

4.1 GENERAL RULES

The following rules govern all desoldering operations, regardless of the tool or technique used. These rules should be understood before attempting to rework modules and shall be adhered to whenever performing desoldering operations.

a. The operator shall match desoldering tool with lead diameter and board thickness /technology.

b. Always follow specification procedures controlling dwell time (how long a desoldering tool should remain in contact with a solder joint when desoldering a component). As a rule, two seconds is usually enough. If not, allow the component/module to cool 15 seconds. Reposition the tool and try again. This procedure reduces the possibility of damaging the module and/or component by overheating.

c. If, at any time, difficulty is experienced in removing solder from a joint, add additional solder to the joint and then attempt again to desolder. This will give better heat transfer to the entire joint and reduce the possibility of damaging the board by overheating.

d. Ensure that the lead moves freely in the through hole before attempting to remove the lead.

e. Never hold a component lead with a metallic tool, such as pliers, while applying heat. The tool will serve as a heat sink and draw the heat from the lead. This impairs adequate heating of the solder joint.

f. When removing leads from PTHs, always confirm that solder is molten in the PTH before attempting to extract the lead.

g. When desoldering components from multilayer boards, difficulty may be experienced in melting the solder. This is due to the inner planes acting as a heat sink. This is true, especially, with pins connected to power and ground planes. In this situation, it may be necessary to apply heat for a longer period of time to ensure that the power and ground pins have reflowed. Adding a small amount of solder to bridge the junction of the tip and solder joint, will provide better heat transfer to the joint. In general, greater care will be needed to remove component leads from multilayer boards without damaging the plated-through hole.

4.2 AXIAL LEAD COMPONENTS

1. Cut the leads from the component on module Side 1, between the bend radius of the lead and the module. Do not cut leads if the component must be reused. Use Pace solder-removal tools for this purpose. When cutting the lead from the component body, be sure not to cut etch or otherwise damage the module surface below the component. Use flush cut dike type cutter (medium).
2. Heat the leads from Side 2 and remove the solder and lead with a solder-removal tool. Use Pace heated vacuum desoldering station models PPS-5, PPS-6, PRC150-A, or Soldapullit with soldering iron. Refer to A-SP-7665334-00-0, *Pace Desoldering System - Process Operator Procedures* for general operational procedures for Pace tools.
3. Clean the area using an approved cleaning solvent. Refer to subhead 3.2

4.3 DIPS, SIPS, SOCKETS, CONNECTORS, PIN GRID ARRAYS

Use Table 2 to determine which desoldering method should be used for components such as DIPS, SIPS, sockets, connectors and pin grid arrays. Then refer to subheads 4.3.1 to 4.3.3 for a definition of the method for each specific tool.

Table 2: Desoldering Tool Matrix for Multilead Through-Hole Components

Board/Device Technology	PACE	PCB Air-Vac* PCB RM10	HART 100	HART 200 /200A	Other
Std. Density 1-sided	Pref.	Pref.	Pref.	Pref.	
Std. Density 2-sided (PTH)	Pref.	Pref.	Pref.	Pref.	
High Density Multilayer	Alt.	Pref.	Alt.	Alt.	Alt.
High Density Multisignal-Layer	N/R	Pref.	N/R	Alt.	Alt.

Legend

Pref. = Preferred Method
Alt. = Alternate Method (to be used when preferred method is not available)
N/R =Not Recommended
N/A =Not Applicable (should never be used for this application).
*Other = Re-circulating solder wave machines are available that perform equally well. Electrovert Soldapak, Wenesco M97A. When using re-circulating solder waves, solder mask must cover the outer layer etch or this method could wash away unprotected etch lines.

4.3.1 HART (Hot Air Repair Terminal) 100 and 200/200A Through-Hole Device Desoldering

To remove components that require the use of a HART desoldering station, reference EL-MF412-00-0, *HART (Hot Air Repair Terminal) 100 Rework System Operational Procedure*, for HART 100 or EL-MF434-00, *HART (Hot Air Repair Terminal) 200 and 200A Rework System Operational Procedure* for HART 200 and 200A.

NOTE

The HART 100 does not have independent heat controls and is not recommended for removal of surface mount components. The HART 200 and 200A models are equipped with independent heat controls and are acceptable, but not preferred. The HART 200A provides 1.5-inch clearance for component height, whereas the HART 200 allows only 0.75-inch clearance.

4.3.2 Air-Vac, Pace or Other Desoldering Methods - Components to be Reused

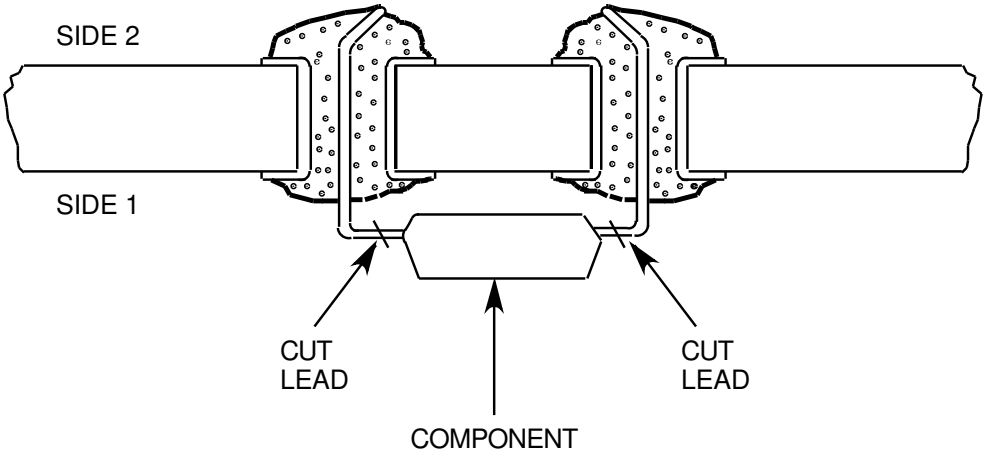
To salvage the component that is being removed, use Air-Vac PCB RM-10 or Pace Ped-A-Vac desoldering station. For details, reference specification A-SP-7665330-00-0, *Air-Vac Module Rework System - Process Operator Procedure*, EL-FS567-00, *Air-Vac PRBRM10 Process* or A-SP-7665334-00-0, *Pace Desoldering System - Process Operator Procedures* or IPC-R-700C.

4.3.3 Air-Vac, Pace or Other Desoldering Methods - Components to be Scrapped

For components to be scrapped after removal, either use the method outlined in IPC-R-700C or use the following method.

1. Cut leads on Side 1. Use a medium flush cut dike-type cutter. (Skip this step if a re-circulating solder wave is being used.)
2. Heat the lead and remove the solder with the solder removal tool.
3. Remove the leads if they remain in the plated-through hole (PTH) after solder removal. Refer to subhead 4.5.
4. Use approved cleaning method to clean reworked area. Refer to subhead 3.2.

Figure 2: Removing Non-Salvageable Components



4.4 REMOVING COMPONENTS WITH LEADS INACCESSIBLE FROM SIDE 1

Refer to Figure 3.

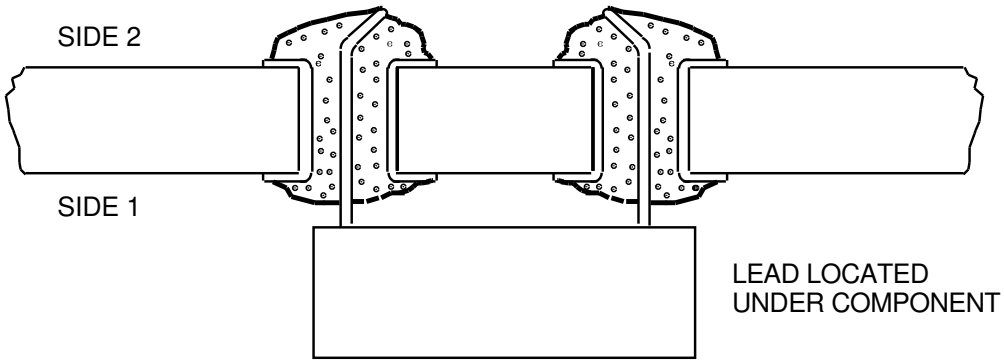
1. Heat the lead and remove the solder from Side 2.
2. Straighten the leads if required.
3. Remove the component.

NOTE

Add a small amount of solder to the soldering iron tip before placing the tip on the lead. This will cause the heat to transfer faster and reduce the possibility of damage to the module.

4. Clean the area using an approved cleaning solvent. Refer to subhead 3.2.

Figure 3: Components with Leads Inaccessible from Side 1



4.5 REMOVING LEADS FROM PTH

In some instances, after cutting leads from the component body, it may be difficult to remove the lead from the PTH because of inadequate removal of solder by the desoldering tool. If this happens, heat the individual leads and remove them while the solder is molten. Use resistance soldering pliers (Pace) or fine tip needle-nose pliers and a desoldering tool.

5 CONTACT FINGER WIRE ADD RULES

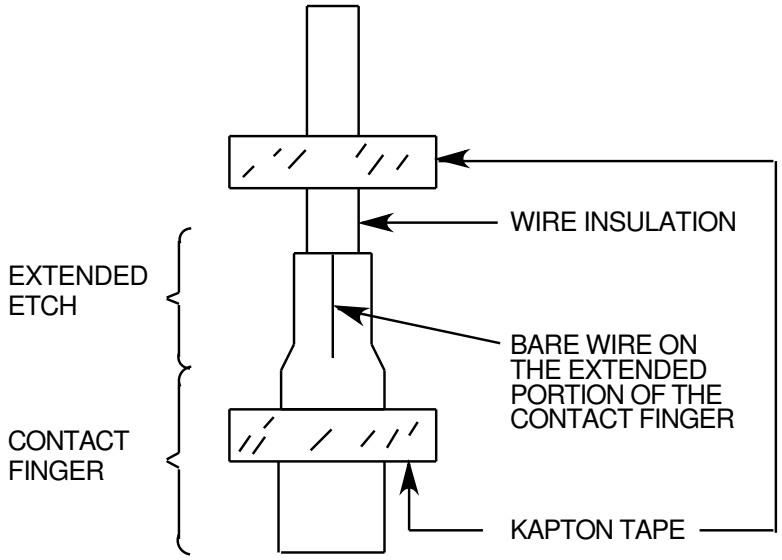
5.1 CONNECTING TO CONTACT FINGERS

When connecting a wire to a contact finger, the wire and solder must be prevented from entering the critical contact area. Refer to *DEC STD 116-0 Workmanship Standards Manual* for a definition of a critical contact area.

5.1.1 Extended Contact Fingers

When installing a wire to an extended contact finger (those connected to circuitry), the wire should be stripped and tack soldered along the extended etch above the contact finger (refer to subhead 3.1.2) or inserted into a connected plated-through hole, if available (see Figure 8). Kapton tape may be used to secure the stripped wire in place while soldering it to the etch. Kapton tape will also keep the solder from running into the critical contact area of the finger. See Figure 4.

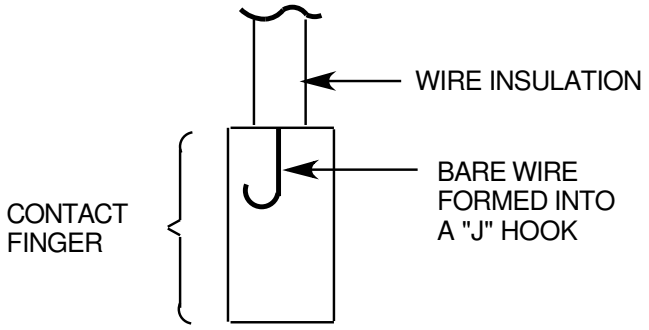
Figure 4: Connecting to Extended Contact Fingers



5.1.2 Unextended Contact Fingers

When installing a wire to an unextended contact finger (those not connected to circuitry), the wire must be tack soldered directly to the contact. Refer to subhead 3.1.2 and Figure 5.

Figure 5: Connecting to Unextended Contact Fingers



NOTE

Kapton tape can be used to hold the stripped wire flush to the contact and also prevent solder from flowing into the critical contact area. For unextended contacts, form a minimum of 0.125 inch (3.17 mm) of stripped wire into a "J" hook shape. This shape will allow a maximum amount of conductor in the termination without the wire entering the critical contact area.

To enhance the cure of the adhesive, apply a small dot of Loctite Tak Pak accelerator prior to placing wire and HV epoxy. When using HV Tough Adhesive, the accelerator must be applied over the adhesive, after the adhesive has been applied to the board.

6 COMPONENT REPLACEMENT

6.1 STANDARD REPLACEMENT PROCEDURE

When replacing components in a through-hole module, use the procedure outlined here.

1. Preform the component leads, if necessary, to fit into the module holes.

NOTE

For preforming component leads, it is recommended to use either pliers with jaws that are not serrated or a preforming tool. All nonmetallic preforming tools should be fabricated of conductive materials to meet Electrostatic Discharge requirements as outlined in *DEC STD 067-0 Handling of Electrostatic Sensitive Devices - Procedures and Protective Materials*.

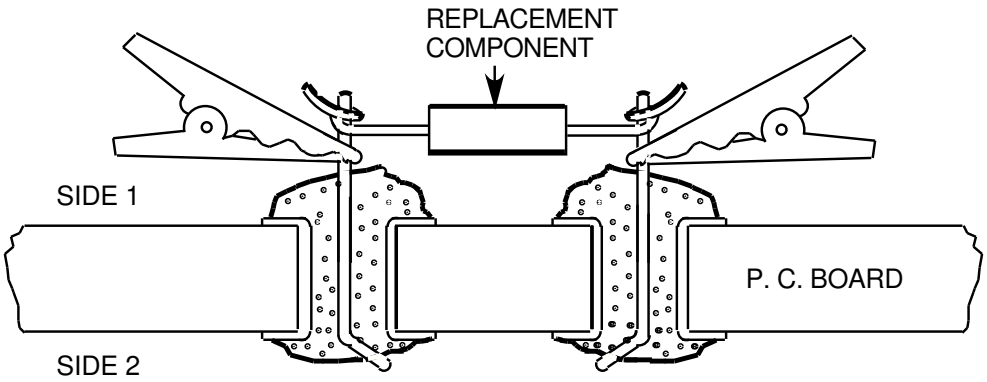
2. Insert component into the board from Side 1. Be sure to follow the mounting rules and polarity requirements.
3. Clip off excess lead on Side 2. Do not cut leads flush to the board surface. Refer to DEC STD 116-0 for lead protrusion requirements.
4. Solder component leads from Side 2 following the procedure as outlined in subhead 3.1.1. Be sure that no shorts exist between through holes.
5. Clean all soldered areas using the approved solvents in subhead 3.2.

6.2 REPLACING AXIAL COMPONENTS WHEN SIDE 2 IS INACCESSIBLE (BLOCKED BY ANOTHER DEVICE)

If solder joints on Side 2 of the module are blocked by a device other than the one to be removed, use the following replacement procedure. See Figure 6.

1. Cut the component body of existing component from its leads.
2. Straighten remaining leads (Side 1).
3. Wrap the replacement component leads around the remaining leads one full turn, as shown in Figure 6.
4. Trim replacement component leads.
5. Solder the wrapped leads to the original component leads. Attach alligator-clip heat sinks to the original component leads to avoid melting solder joints in board. Minimize heating time with the soldering iron to prevent solder from dropping to the device below. Place a sheet of nonflammable conductive material between the module and the lower device to protect Side 2 device from solder drip.
6. Clean area with approved cleaning solvent. Refer to subhead 3.2.

Figure 6: Replacing Components when Side 2 is Inaccessible (Blocked by Another Device)



7 COMPONENT ADDITIONS

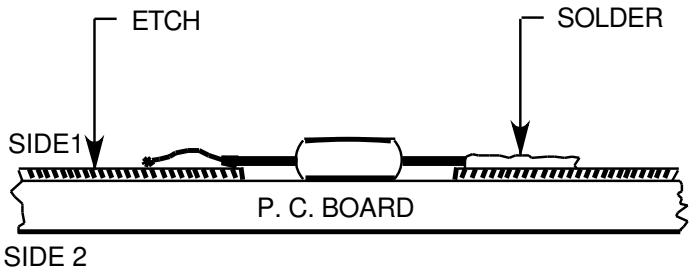
In situations where additional components are to be added per an ECO, the following rules apply.

a. 1/4-watt resistors and other similar sized components may be soldered directly to the etch without any further mechanical support. Refer to Figure 7 and subhead 3.1.2.

NOTE

Tack soldering is not allowed under any circumstances on fine line modules (etch widths of 0.008 inch or less).

Figure 7: Soldering to Etch



b. Components are not to be soldered directly to other components unless specified in the ECO documentation package. This is not a preferred method and should be avoided if possible.

c. Adding components when there are no available holes for this addition, will require holes to be drilled in the modules and griplets to be installed (ECO will describe the hole location). This does not apply to multilayer boards. Refer to Table 3, which indicates Berg Funnel head griplets of phosphorus/bronze material for nominal board thickness of 0.06 inch (1.59 mm). Griplets (after installation in the holes) are not to be located within 0.010 inch (0.25 mm) of any existing pad/etch line or other griplets to which they should not be connected.

Table 3: Griplet/Drill Size Chart (Berg Griplets)*

Strip Form Part Number	Griplet Size	Drill Size
Digital part number 12-10244-01	0.050 inch	Number 54

* Available from Berg Electronics, 142 Reno Street, New Cumberland, PA 17070

d. When components with more than two leads (such as ICs, transistors, and transformers) are to be added and no pre-drilled hole pattern exists, holes must be drilled using the correct drill size (per ECO) and griplets must be inserted.

e. Components may be installed in holes that already have components, provided that the leads are able to fit in the same hole without using force.

NOTE

Never attempt to increase the size of the plated-through hole.

f. Thin wall extruded tubing (per A-PS-9100001-GS-0) is to be used on component leads that are near an etch or where any potential short may exist.

8 ETCH REPAIR

The guidelines listed below are to be followed when performing any etch repair defined in subheads 8.1 to 8.4.

An alternative procedure to the ones listed here can be found in EL-MF362-00*Etch Repair Procedures*.

a. Etch that has been lifted, but not damaged, can be repaired by using an approved adhesive (2115 Epoxy from Tracon, or equivalent). Apply a small amount of adhesive under the etch. Be sure that the adhesive does not flow into the plated-through holes, onto nearby components, or onto any surface that may later be required to accept solder.

b. Module etch repair can be done using number 30 AWG, white Kynar wire for circuit widths above 0.008 inch (0.20 mm). A heavier gauge wire may be required for printed circuit boards used in power supplies. Table 4 lists specific wire gauges to be used to repair corresponding circuit widths.

Table 4: Circuit Width versus Wire Gauge

Circuit Width		
inch	mm	Wire Gauge (AWG)
0.005	0.13	PTH-to-PTH or Kovar ribbon
0.008	0.20	30
0.012	0.31	30
0.015	0.38	30
0.030	0.76	30
0.050	1.27	28
0.075	1.90	26
0.100	2.54	24
0.150	3.81	22
0.200	5.08	20
0.250	6.35	20

c. Any portion of etch that has been lifted and damaged must be cut and removed. Refer to heading 4 before repair.

d. Wires required for etch repairs on Side 2 must be installed after the wave solder process.

e. All areas soldered or desoldered must be cleaned using the approved cleaning solvent. Refer to subhead 3.2.

f. Wire bonding must follow requirements in heading 21.

g. Wires installed for etch repairs are to be run as closely along the original etch path without violating wire installation rules as outlined in heading 5.

8.1 SIDE 1 OR SIDE 2 MISSING ETCH, 0.25 INCH OR LESS

Etch repair (except fine line) where the missing etch is 0.25 inch (6.35 mm) or less (Side 1 or Side 2) is as follows.

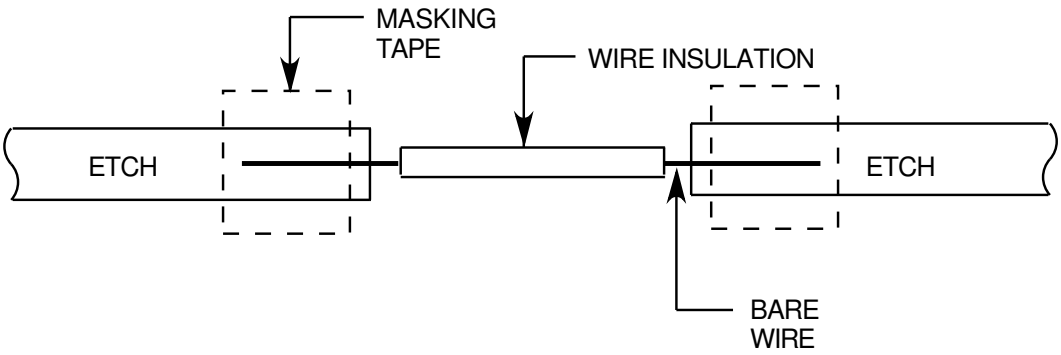
1. Remove the insulation from the wire.
2. Position the bare wire to extend across the break over both ends.
3. Apply Kapton tape over the extending wire ends leaving 0.125 inch (3.17 mm) to 0.25 inch (6.35 mm) exposed beyond both ends of the break.
4. Tack solder the wire to the etch, ensuring that the solder connection, wire to etch, is 0.125 inch (3.17 mm) to 0.25 inch (6.35 mm).
5. Remove tape and clip excess wire ends.
6. If the break is near a plated-through hole to which the etch was originally connected, the stripped end of the wire may be inserted and soldered into the hole. Insulation must not extend into the hole.

8.2 SIDE 1 MISSING ETCH GREATER THAN 0.25 INCH

Etch repairs, except for fine line, where the missing etch is greater than 0.25 inch (6.35 mm) on Side 1, shall be repaired using insulated wire to replace the missing etch. Use the following steps:

1. Strip the wire ends, using insulation length sufficient to extend the length of the missing etch.
2. Extend stripped ends of wire over both ends of the etch with insulation positioned across the break. Insulation should not extend onto the etch.
3. Apply Kapton tape as shown in Figure 8 over the extended wire ends, leaving 0.125 inch (3.17 mm) to 0.25 inch (6.35 mm) exposed beyond the ends of the break.
4. Solder the wire directly to the etch. Ensure that the solder connection of the wire to the etch is between 0.125 inch (3.17 mm) and 0.25 inch (6.35 mm) in length.
5. Remove tape and clip excess wire ends.
6. Bond wire at two-inch intervals and at each change in direction.

Figure 8: Etch Repair



8.3 SIDE 2 MISSING ETCH GREATER THAN 0.25 INCH AND ALL FINE LINE

Etch repairs, where the missing Side 2 etch is greater than 0.25 inch (6.35 mm), shall be repaired by adding insulated wire on Side 1. The wire shall be added from PTH to PTH, re-establishing the damaged etch line. The wire may be added on Side 2 if either of the terminating points on Side 1 are inaccessible (blocked by a component such as a connector). Refer to subhead 21 for bonding requirements for Side 2 wire additions. This procedure is also to be used for repairing any broken etches on fine line boards.

1. Trace each end of the broken etch to the nearest attached plated-through hole.
2. If solder is present in the plated-through hole, remove per desoldering procedure in heading 3.
3. Locate connection points on Side 1. If either of the connection points are blocked by a component such as a connector, add the wire on Side 2. If connection points are not blocked on Side 1, add wire on Side 1.
4. Strip wire ends and insert stripped ends through identified PTHs from side of board to which wire is being added.
5. Solder wire in holes from opposite side of wire installation.
6. Bond wire to board per methods outlined in heading 21. Note the different bonding requirements for Side 1 and Side 2 wire additions.
7. Clean all soldered areas with approved solvents listed in subhead 3.2.

8.4 FINE LINE ETCH REPAIR (ETCHES 0.008-INCH WIDE OR LESS)

Never solder wires directly to etches on fine line boards to make etch repairs. fine line boards are those with etch line widths of 0.008-inch (0.20 mm) or less. Repairs are performed by adding wires from PTH to PTH. For fine line etch repairs, use the procedure outlined in subhead 8.3. Note that this technique applies to both Side 1 and Side 2 broken etches.

NOTE

Refer to heading 21 for wire placement and routing on Side 2.

Specification EL-MF362-00 describes the preferred procedure for repair of fine line etch. These procedures involve welding Kovar metal ribbon directly to the etch.

NOTES

Never solder wires directly to etch lines on fine line boards. Etch repairs are to be accomplished by adding wires from PTH to PTH.

Wires installed to re-establish broken etch connections are to be run as closely along the original etch path as possible without violating wire installation rules as outlined in heading 21.

9 CIRCUIT PAD (PTH ONLY) REPAIR

9.1 LIFTED PADS (PTH)

Lifted pads, with or without attached etch, that are not damaged can be repaired by using an approved adhesive.

1. Apply a small amount of cyanoacrylate adhesive (approved adhesives are listed in heading 12) under the pad. Ensure that the adhesive does not flow into PTH or onto component leads.
2. Apply light pressure on pad against the board and hold while adhesive cures.
3. Remove any adhesive that flows from under the pad or comes in contact with the PTH or component leads with solvent.

NOTE

Some adhesives may require ultraviolet light or a bake cycle to cure.

9.2 MISSING PADS (PTH)

Missing pads (Side 1 or Side 2) that were originally connected to one or more etch lines may be repaired by using the procedures outlined below. Use subhead 9.2.1 for standard density boards and subhead 9.2.2 for fine line boards. Missing pads that were not originally connected to etch lines do not require repair.

NOTE

DEC STD 116 allows only 10% missing pads per component configuration.

9.2.1 Pad Repair for Standard Density Boards

1. Cut and strip a section of number 30 AWG wire. Wrap one end of the wire at least one full turn around the component lead to be inserted into the PTH missing the pad.
2. Extend the other end of the wire to the etch to be attached to and solder it to the etch. See subhead 3.1.2 for tack soldering requirements.
3. Repeat this operation to reconnect all broken etches.
4. From the side with the missing pad, solder the component lead and all wrapped wires into PTH.
5. Clean all soldered areas with appropriate solvents listed in subhead 3.2.

9.2.2 PTH Pad Repair for Fine Line Boards

1. Strip one end of white number 30 AWG wire and wrap at least one full turn around the component lead that is to be inserted into the PTH.
2. Trace the broken etch line to the nearest PTH and extend the other (insulated) end of the wire to that location. Strip the end of the wire and desolder the PTH. Insert wire into the PTH. Solder the wire and component lead (if present) in the PTH. Bond wire to board following guidelines under heading 21.
3. Repeat this operation to reconnect all broken etches. If it is easier to wrap leads after a component is placed, do so.

4. From the side of the missing pad, solder the component lead and all wrapped wires into PTH.
5. Clean all soldered areas with appropriate solvents listed in subhead 3.2.

9.3 DAMAGED PTH REPAIR

A damaged plated-through hole may be repaired by drilling the hole and installing the appropriate size griplet (refer to heading 21). The preferred method to repair the PTH is to use the through connection wire repair methods outlined in subheads 9.3.2 and 9.3.3.

NOTE

The griplet method does not apply to multilayer modules.

An alternative method for repairing a PTH is described in specification EL-MF362-00.

9.3.1 PTH with Attached Conductors - Griplet Method

If the griplet method is used to repair a damaged PTH and attachments are to be made to conductors, follow the procedure outlined below.

1. Strip a section of number 30 AWG wire.
2. Place the stripped wire through the griplet and solder to connecting etch on Side 1 and/or Side 2. If board is fine line, run wire to nearest attached PTH. Desolder PTH, place wire in PTH and resolder component lead (if present) and wire in PTH. Secure wire as required. Refer to bonding rules specified under heading 21.
3. If connecting etch has been damaged more than 0.25 inch (6.35 mm) from the PTH, follow the etch repair procedures under heading 8.

9.3.2 Through Connection Method - Multilead Components (DIPs or Transistors)

If the installation of a griplet may possibly create shorts to neighboring component holes, follow the procedure outlined below. This procedure can be used for repairing multilayer boards with no inner layer connections.

1. Desolder the component lead from the damaged plated-through hole.
2. Cut the lead that corresponds to the damaged plated-through hole above the seating plane and remove the cut section of the lead. The remaining lead must be short enough so that it does not enter the hole.
3. Drill the hole (if necessary) using a number 54 drill. Inspect for copper smears between inner layers. Test the board electrically for inner layer shorts. See note under subhead 9.3.3 for method of testing for inner layer shorts.
4. Using a number 30 AWG white repair wire, strip one end and wrap it one or two full turns around the remaining section of the lead. Solder wire to the lead.

NOTE

An easy method of wrapping the wire is to form a small loop in the uninsulated end of the wire. Slip it up and over the section of the lead and pull both ends of the wire out as if to tie a knot. This will create one and one half wraps of wire around the lead. After soldering, cut uninsulated wire (the end closest to the lead). Be sure that there is no possibility of contacting an adjacent lead or etch.

5. If the connecting etch is on Side 1, component side, strip the second end of the wire, and solder to the etch. Refer to subhead 3.1.2. If the connecting etch is on Side 2, extend insulated wire through the drilled hole and solder the wire to the etch on Side 2.

CAUTION

For fine line boards, do not solder any wire to etch lines. Etch repairs should be done adding wire PTH to PTH.

6. Clean all desoldered or soldered areas with the approved cleaning solvent. Refer to subhead 3.2.
7. Bond the wires following the requirements in heading 21.

9.3.3 Through Connection Method - Radial or Axial Components

If the installation of a griplet in a PTH for an axial or radial component may possibly create shorts to neighboring component holes, follow the procedure outlined below. This procedure can be used for repairing PTHs with no inner layer connections on multilayer boards. If a module is marked anything but L2 on Side 2, it is a multilayer board.

1. Desolder the component lead and remove it from the hole.
2. Drill the hole (if necessary) using a number 54 drill. Inspect the hole for copper smears between the layers and test for inner layer shorts.

NOTE

To test for shorts, determine power source, ground or signal pins for that particular section of the module from corresponding circuit schematic; then check appropriate pins with a digital ohmmeter or equivalent low-current, low-voltage meter to determine if an open condition exists between the layers.

CAUTION

A continuity light or standard ohmmeter can damage integrated circuits and transistors. The damage is not always apparent at the time it is created.

3. Apply thin wall extruded tubing (spaghetti tubing per specification A-PS-9100001-GS-0) over component lead and insert lead through the drilled hole. The tubing must extend through the hole; then it must be trimmed close to the module on Side 2.

After completing Steps 1, 2 and 3 above, complete the repair by following one of the methods outlined below. Refer to the following subheads:

9.3.3.1 for holes with attached conductors on Side 1.

9.3.3.2 for holes with attached conductors on Side 2.

9.3.3.3 for holes with attached inner layer conductors.

9.3.3.1 Attached Conductor on Side 1

1. Clinch the lead flush to Side 2 of the printed-circuit board and trim the excess lead.
2. Apply a small amount of epoxy (Ecco-bond) to the lead to secure it to the board.
3. Strip a section of number 30 AWG wire and wrap one end at least one full turn around the component lead on Side 1. Solder the wire to the lead.

4. Extend wire across conductor to which it is to be attached. Solder to etch per procedures in heading 10 and trim excess wire. If board is fine line, run insulated wire to nearest attached PTH. Desolder PTH, place wire in PTH and resolder component lead (if present) and wire in PTH. Follow the guidelines under heading 21 for wire bonding requirements.
5. Clean all soldered/unsoldered areas using approved solvents listed under subhead 3.2.

9.3.3.2 Attached Conductor on Side 2

1. Clinch the lead flush to Side 2 of the module. Make sure that it is parallel with the attached etch.
2. Clip the lead if it exceeds 0.25 inch (6.35 mm) and tack solder directly to the etch following procedures subhead 3.1.2. If board is fine line, run insulated wire from the lead to nearest attached PTH. Desolder PTH, place wire in PTH and resolder component lead (if present) and wire in PTH. Follow the guidelines under heading 6 for wire bonding requirements.
3. Clean desoldered or soldered connections with approved solvents. Refer to subhead 21.

9.3.4 PTH Jumper Wire Repair Method (Z-Strap)

If the installation of a griplet to repair a damaged PTH could possibly create a short to neighboring component holes on either a two-sided or multilayer board with no inner-layer connections, the following procedure may be used.

1. Desolder the damaged plate-through hole and remove component lead if present.
2. Insert an uninsulated number 30 AWG wire through the PTH and solder it to the pads of the PTH on both sides of the module. See Figure 9.
3. Replace the component lead (if present) into its original PTH and resolder. See Figure 10.
4. Trim the number 30 AWG wire to ensure that it does not contact adjacent etch of PTHs.
5. Clean soldered/desoldered areas with solvents listed in subhead 3.2.

NOTE

On a fine line module with connecting etch to the PTH, the barrel can be repaired with the Z-strap method. However, the jumper CANNOT be used to make connections to the etch (for example, by soldering the jumper to the etch). Electrical connections are to be made by installing an insulated wire from PTH to PTH, following original etch lines.

Figure 9: Via Hole with No Component Lead

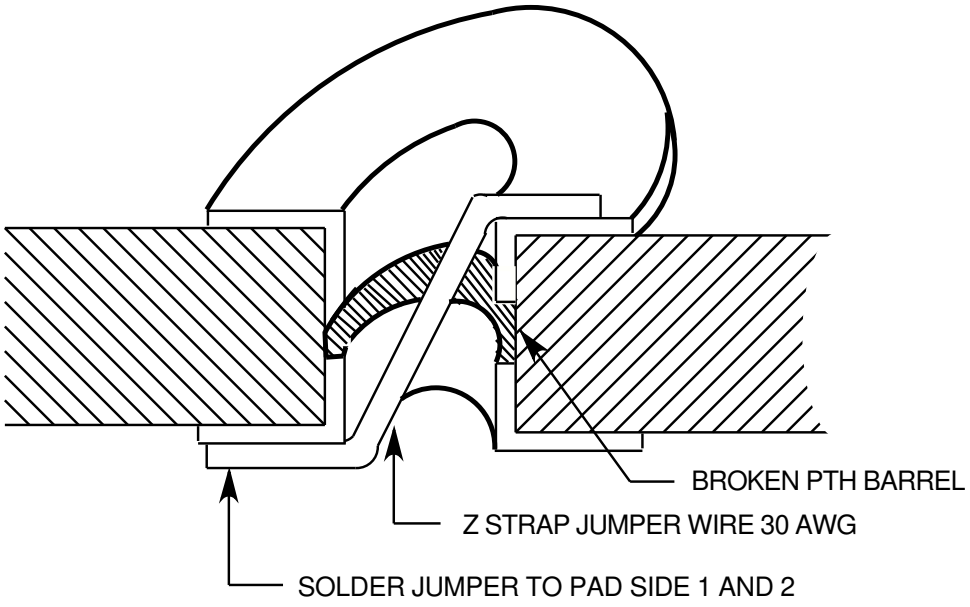
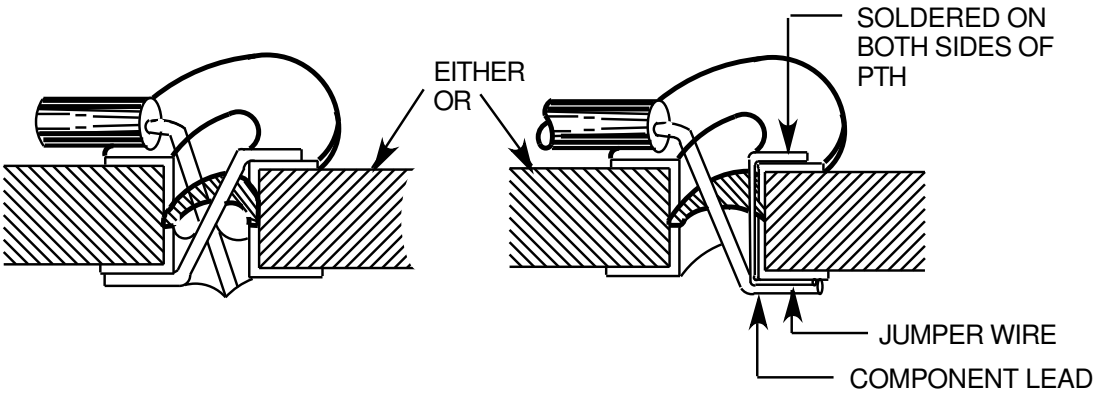


Figure 10: Component Replacement Examples



10 REMOVING INTERNAL SHORTS FROM MULTILAYER MODULES

Short circuits between inner conductive layers that are not accessible at a plated-through hole can be repaired, but repair requires equipment and process techniques not normally available in a module repair area.

10.1 PROCEDURE

Repairs can be made to remove a short from between a plated-through hole and an inner layer in a module repair area. Follow the procedure described here, or for an alternative method, refer to specification A-SP-7665372-00-0, *Inner Layer Shorts Rework Procedure*.

NOTE

To detect/isolate a short on the module, test equipment is usually used. To understand where the suspect etch is connected, the VLS, or other design data bases can be used.

To repair this defect proceed as follows:

1. Desolder the plated-through hole using techniques outlined in heading 4.
2. Drill the hole using a number 54 drill. Inspect the board for copper smears between the layers and electrically test for inner layer shorts. If the short still exists, repeat drill and test operation. See note and caution under subhead 9.3.3.
3. Complete the operation by following the procedure under subhead 10.1.1 or 10.1.2.

10.1.1 Holes Without Attached Conductors

Use the following procedure for a hole without an attached conductor.

1. Fill the hole with epoxy (Ecco-bond) if the repair is made prior to wave solder; or leave the hole open if the repair is made after wave solder. There is no need to fill it with epoxy.
2. Clean the area with approved solvents that are listed under subhead 3.2.

10.1.2 Holes With Attached Conductor

NOTE

This procedure is not allowed when an attached conductor is fine line etch of 0.008 inch or less.

Use the following procedure for a hole with an attached conductor.

1. Strip one end of number 30 AWG white wire and solder directly to the attached etch. Refer to heading 3.1.2.
2. Route insulated wire to the nearest location that can reconnect the circuit.
3. Strip the end of the wire and solder directly to the etch (refer to subhead 3.1.2) or insert it through the plated-through hole and then solder it.
4. Clean the desoldered/soldered areas with the approved solvent. Refer to subhead 3.2.
5. Bond the wires following the requirements under heading 21.

10.2 REPAIR OF PLATED-THROUGH HOLES

Inner layer short containing a lead of a multilead component such as a DIP or transistor can be repaired as follows.

1. Desolder the plated-through hole from Side 2.
2. Cut the component lead on Side 1 above the seating plane on the module surface. Remove the cut section of lead from the plated-through hole. The remaining section of lead must be short enough that it does not enter the hole.
3. Drill the hole from Side 2 using a number 54 drill. Electrically test the board for inner layer shorts. If shorts exist, repeat drilling and test operation. See note and caution under subhead 9.3.3.
4. Strip one end of white number 30 AWG wire and wrap it at least one full turn around the remaining section of the lead. Solder the wire to the lead.
5. Extend the insulated wire to meet circuitry, etch, or plated-through hole to which it will be connected. Provide stress relief from the lead to connection. If a connection is to be made on Side 2, extend insulated wire through drilled hole.
6. Strip second end of the wire and solder to desired connection. If module is fine line, connection must be made to a plated-through hole.
7. If plated-through hole had multiple connections, Steps 4 through 6 are to be repeated until all appropriate connections are made.
8. Clean the desoldered/soldered areas with approved solvents listed under subhead 3.2.
9. Bond wires following requirements in heading 21.

10.3 PLATED-THROUGH HOLE/INNER LAYER SHORT

A PTH/inner layer short containing a lead of an axial/radial lead component can be repaired as follows.

1. Desolder the component leads from Side 2 and remove the component.
2. Drill out the shorted plated-through hole, using a number 54 drill, inspect for copper smears between the layers and test the board for inner layer shorts. If the short still exists, re-drill carefully and then retest. See note and caution under subhead 9.3.3.
3. Apply thin wall extruded tubing (spaghetti tubing per specification A-PS-9100001-GS-0) over the component lead and insert the lead through the drilled hole. Tubing must extend through the hole, then trim the lead close to the module on Side 2.
4. If an inner layer is disconnected, it must be reconnected, per the circuit schematic drawing or VLS layup data, by soldering a wire to and from the two signal termination points.
5. Clean all unsoldered or soldered connections with approved solvent. Refer to subhead 3.2.

NOTE

If attached to conductor Side 1, omit Step 3.

10.3.1 Attached Conductor Side 1

Omit Step 3 above and tack solder the lead directly to the etch. If the board is fine line, trace etch to nearest attached PTH, desolder hole. Extend stripped end of wire to hole. Solder wire and component lead (if present) in PTH. Clean with approved solvents listed under subhead 3.2.

10.3.2 Attached Conductor Side 2

1. Clinch lead flush to Side 2 of the module. The lead should be parallel with the attached etch. If board is fine line, trace etch to nearest attached PTH, desolder hole. Extend stripped end of wire to hole. Solder wire and component lead (if present) in PTH. Clean with approved solvents listed under subhead 3.2.
2. Clip the lead if it extends 0.25 inch (6.35 mm) and tack solder directly to the etch.
3. Clean all unsoldered or soldered connections with approved solvents listed under subhead 3.2.

10.3.3 Attached Inner Layer Conductor

1. Clinch lead flush to Side 2 of the module.
2. Clip excess lead ensuring that no shorts exist.
3. Apply a small amount of epoxy (Ecco-bond) to the cut lead to secure it to the printed circuit board.
4. Strip one end of the number 30 AWG white wire and wrap it one or two full turns around the component lead on Side 1.
5. Extend insulated wire to connect to the nearest etch or plated-through hole attached to the same layer.
6. Clean all desoldered or soldered connections with approved solvents listed under subhead 3.2.
7. Bond the wires to the board. Refer to heading 21.

11 REPAIR OF BLISTERED OR DELAMINATED BOARDS

Use the following procedure to repair modules that have blistered or delaminated during the manufacturing process.

CAUTION

Because of the damage risk posed by multilayer module lay-ups, this procedure is primarily used only on 2 - 4 layer modules.

11.1 TOOLS AND MATERIALS REQUIRED

a. No. 56 drill bit

b. Plastic syringe, 2.5 cc, - Vendor: Fisher Scientific, Medford, MA.

c. Epoxy kit, Stycast No. 1266 - Vendor: Emerson Cummings, Canton, MA (617) 828-3300. Approximate cost: $(USD)12.00/kit.

11.2 PROCEDURE

1. Locate the blistered area.
2. Drill two holes into the blister, approximately 1/16 inch (1.574 mm) from the edge of the blister and 1/32 inch (0.787 mm) deep. One hole is to be used to inject fluid into the blister and one is used to allow air to escape.
3. Mix Stycast No. 1266 parts A (epoxy) and B (catalyst) according to the manufacturer's directions.
4. Fill plastic syringe with mixed epoxy.
5. Insert the syringe into one of the drilled holes and fill the blister with epoxy. Wipe off excess epoxy.
6. Cure the module at room temperature (approximately 75°F [170°C]) for 8 to 12 hours. The curing period can be shortened to one hour by baking the module at 100°F (220°C).

NOTE

The following steps do not apply to single-sided boards.

7. If a component hole contacts any portion of a blister, and if a component lead is evident in the hole, the pads on both sides of the board must have a solder fillet to insure good electrical contact. Resolder if necessary.
8. If a via hole contacts a blister, insert a piece of number 30 AWG wire in the hole, cut, clinch, and solder to both sides to ensure a good electrical contact.

12 RECOMMENDED VENDORS

This section lists vendors who supply tools that are recommended throughout this document. It is not imperative that these tools be purchased through these particular vendors.

Table 5: Recommended Vendors

Hand Desoldering Tools	Vendor
SRT	Sierra Technologies Powers Road Westford MA (508) 932-0635
HART 100, 200, 200A	Arch Manufacturing, 1213 South 6th St. Camden, NJ 08104 (609) 966-3835
Pace Desoldering Tools: PPS-5,PPS-6,PRC-150-A	Linden Sales 33B Street Burlington, MA 01803 (617) 272-5100

Desoldering Tips	Vendor
Pace Tips:	
Fine Line Boards O.D. = 0.025 inch (0.640 mm)	VPN 1121-0214
Standard Density O.D. = 0.036 inch (0.910 mm)	VPN 1121-0215
Power Supplies O.D. = 0.061 inch (1.550 mm)	VPN 1121-0217
Air-Vac PCBRM-10 Desoldering Station:	Air-Vac Engineering Company Inc. 100 Gulf Street Milford, CT (203) 874-2541

Table 5 (Cont.): Recommended Vendors

Etch Cutters	Vendor
Automated etch cutter	Automation Unlimited 10 Rustler Road Woburn, MA 01801 (617) 933-7288
Dremel tool No. 3801	Kaufman 110 Second Street Cambridge, MA 02141
End Mills - Europe	Drill Service Ltd. 23 Albert Road Horley, Surrey, UK
End Mills	Richards Microtool Plymouth MA
Starlite air grinder No. 501005 Starbide drill bit No. 418005	Refco 730 Main Street Boylston, MA 01505 (508) 869-2106
Pace fine etch cutting tool No. PM-166	
Pace ball mill No.1112-0001 (0.016 inch [0.410 mm] diameter) No.1112-0002 (0.031 inch [0.790 mm] diameter)	Linden Sales 33 B Street Burlington, MA 01803 (617) 272-5100
Dentist's drill bits No. 2 straight handpiece-SS White Pennwalt	Bay Dental Supply Cummings Park Woburn, MA 01801 (617) 933-7850

Soldering Irons	Vendor
Weller Ungar 9000 or 9200 METCAL STSS-001	Contact East 7 Cypress Drive Burlington, MA 01803 (617) 272-5051

Table 5 (Cont.): Recommended Vendors

Accelerators and Solvents	Vendor
Loctite Products	
Product Part Number	
Loctite 414 adhesive	Digital part number 49-01272-00
Loctite 420 adhesive	Digital part number 90-09157-01
Loctite elastomer bond adhesive	Digital part number not available Vendor P/N 12833
Tak Pak kit	Digital part number 49-01401-00
Loctite HV tough adhesive	Digital part number not available Vendor P/N 12876
XNMS clean-up solvent	Digital part number not available Vendor P/N 76826
	Loctite Corporation 703 North Mountain Rd. Newington, CT 06111 (203) 278-1280

Adhesive Dispensers	Vendor
Bond-A-Matic 2000 Model 200	Loctite Corporation 703 North Mountain Rd. Newington, CT 06111 (203) 278-1280
Electron fusion devices Model 1000DV	Norlico Box 342 Peterborough, NH 03458 (603) 924-7307

Griplets	Vendor
	Berg Electronics 142 Reno St. New Cumberland, PA 017070 1-(800) 237-2374

Tape	Vendor
Kapton tape	C.H.R. Industries Inc. Armco Co . New Haven, CT 06509 (203) 777-3631

Table 5 (Cont.): Recommended Vendors

Wave Solder Equipment	Vendor
Re-Circulating Solder Wave Equipment	Air-Vac Engineering 160 Gulf Street Milford MA or Wenesco M93 or Electrovert Soldapak

13 PIN GRID ARRAY REMOVAL AND REPLACEMENT

13.1 INTRODUCTION

The PGA removal and replacement method defined here has been tested and verified by microsectioning and test cases on multilayer modules up to 0.147 inch (3.733 mm). Data is available upon request.

13.2 DESCRIPTION

The process defined here is applicable for Pin Grid Arrays that are directly soldered to the module without the use of Mark Eyelets. The method defined is a valid process for removing and replacing PGAs from 72 to 299 pins. The only repair equipment that has been proven to work are re-circulating solder wave machines that pump molten solder to the bottom side of the board during the entire removal and replacement operation. The use of single-point solder extraction/vacuum tools is not recommended.

Process Flow	Recommended Equipment
• Identify suspect PGA	Test
• Remove all ECO and repair wires if necessary	Soldering iron
• Straighten old device leads, if necessary	Desoldering iron
• Clean local area near suspect device	Brush / cloth
• Preheat module	Hotplate, Infrared lamps, Oven (4+ hours oven, 80°C I/R, ± 5°C, JGO), Forced hot air
• Straighten new device leads	Pin straightening fixture
• Clean and flux new device	Dip clamps and flux tray
• Dip PGA leads in 63/37 solder twice (gold-plated leads only)	Re-circulating solder wave, pre-tin tool kit, pliers
• Preheat new device (PGAs only)	Hotplate (short interval), oven (15 min)
• Flux suspect device area (solder side)	Brush
• Position board over wave	Fixture may be required
• Flux leads new device	Dip in flux filled tray
• Contact Side 2 with molten solder wave	Re-circulating solder wave
• Remove suspect device	PGA removal tool
• Insert new PGA while solder is molten	PGA positioning tool or by hand
• Remove / lower solder wave	Timer activated or foot switch
• Cool module	Ambient air
• Clean local area	Solvent
• Replace wires	Soldering iron
• Test and inspect	Tester and microscope

13.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up and operating procedure refer to the documents listed here.

Document Identifier	Title
A-MN-ELFS567-00-0	*Air-Vac PRBRM10 Process*
A-MN-ELMF502-00-0	*Electrovert Soldapak Process*
No number assigned	*Wenesco M97A Process*
	JGO Process Documentation
A-PG-PCBRM-10-JG00	*ZEVAC (De) Solder Process Guide*
A-TP-PCBRM-10-JG00	*Generic Machine/Maintenance Procedure*
A-TP-PCBRM-10-JG01	*ZEVAC PCBRM-10 Operator Manual*
D-AD-9513887-0-0	*Universal PGA Pin Straightner*
D-MD-9621150-0-0	*ZEVAC PCBRM-10 Fixture Drawings*
B-DD-9309680-0-0	*JGO Upgrade Kit Infrared Preheat Drawings*
B-DD-9310147-0-DBU	*ZEVAC PCBRM-10 Pre-tin Kit*

Use VTX SMC to order documents from Standards and Methods Control.
Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

13.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

Re-circulating solder waves (Choose one)	Air-Vac PCBRM10 or PCBRM12 Electrovert Soldapak Wenesco M97A
Side 2 preheaters (Choose one)	Lindberg 53015 hotplate Infrared lamp kit for PCBRM-10 (JGO)(Print Set No. B-DD-9309680-0-0)
Side 1 preheat- if I/O is over 144	Leister 3000
Oven preheating	Memmert Oven type UL40 from Wet Equipment, Europe
Fixturing (in-house designs)	Pin straighteners (Maynard Print Set, consult author) Module holding frames Tinning support frame (Print Set No. D-MD-9621150-0-0) Flow Well removal tools (Maynard Print Set, consult author) Universal PGA Pin Straightener (95-13887-00) ZEVAC PCBRM-10 Pre-tin Kit (Print Set No. B-DD-9310147-DBU)
Materials	63/37 SnPb solder RMA flux (Alpha 611) 111-Trichlorethane or site-specified alternative, (Alpha 565) solvent Freon TE-35 solvent Oil-blanket (only used when compatible with cleaning process)

13.5 LIMITATIONS

Extreme care must be taken not to stress the module during the removal and replacement cycle to avoid inducing internal damage. Pulling or pushing on a device, to remove or replace it, will cause internal mechanical damage unless every joint is completely molten. Preheating MSL modules is necessary to prevent the modules from delaminating and blistering, due to Z-axis expansion that is not visible during a repair operation. Z-axis expansion is the leading cause of failure in many boards that have been repaired.

13.6 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required.

CAUTION

The wave height, module thickness, process parameters, and moisture content in the board, and operator training all play a vital role in the success of this process. Therefore an understanding of each variable is absolutely necessary.

13.7 TRAINING AND SUPPORT

Training and support are available from TRG Training at Andover, MA (AET), Field Service Module Repair \Training Group in Andover, MA (DAS), and from the Training Group (ECN) in Nijmegen, the Netherlands (JGO).

14 MARK EYELET REMOVAL

14.1 INTRODUCTION

The Mark Eyelet removal and replacement method defined here is recommended as a fix for modules that exhibit intermittent test failures or modules that are sensitive to vibration. It is a very machine time-consuming process that has only been tested on limited types of modules.

The recommendation is to remove all Mark Eyelets on the module. However, as a minimum, it is mandatory to remove all Mark Eyelets within a single Pin Grid Array footprint.

14.2 DESCRIPTION

The process defined here is applicable for Pin Grid Arrays that are inserted in individual sockets known as Mark Eyelets. The method defined is a valid process for removing any Mark Eyelet on a module. The referenced documentation, however, specifically addresses Mark Eyelets used to connect PGAs with the pin counts of 72, 120, 133, and 144. The only tool recommended for this process is an automated etch cutter with surface sensing capability. Automation Unlimited EC83 is the machine recommended for removing Mark Eyelets. The use of single-point desoldering tools, a combination of one soldering iron and a desoldering tool, or Dremel tools are unacceptable.

Process Flow	Recommended Equipment
• Identify suspect set of Mark Eyelets	Test
• Remove all ECO and repair wires	Soldering iron
• Remove socketed devices	PGA extractor or dip extractor
• Generate a program to rework module	C60 Controller and EC83
• Change tool in etch cutter	End mills 3/32 inch (2.38 mm) diameter
• Set up populated module fixture	EC83 uni-fixture
• Load board side 1 up on fixture	EC83 uni-fixture
• Cut top side of all Mark Eyelets	EC83 etch cutter
• Turn board over on fixture side 2 up	EC83 uni-fixture
• Cut bottom side of all Mark Eyelets	EC83 etch cutter
• Inspect clear through-holes	Dental pick and microscope
• Clean reworked area	Solvent and brush
• Straighten device leads	Pin straighteners
• Dip device leads in flux	RMA flux
• Tin device twice (If leads are exposed Gold)	Tinning frame
• Continue using the PGA replacement process previously defined.	Re-circulating solder wave

14.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up and operating procedure refer to the documents listed here.

Document Identifier	Title
A-MN-ELFS566-00-0	*Mark Eyelet Removal Process Guide*
A-MN-ELMF422-00-0	*Automated Etch Cutter Operator's Manual*
A-MN-ELFS567-00-0	*Air-Vac PRBRM10 Process*
A-SP-ELMF502-00-0	*Electrovert Soldapak Process*
No number assigned	*Wenesco M97A Process*
A-AM-MEYELET-00-JG00	*Mark Eyelet Removal Operator's Manual*
A-PG-MEYELET-00-JG00	*Mark Eyelet Removal Process Guide*
A-PG-MEYELET-00-JG00	*Mark Eyelet Removal Programmer's Guide*

Use VTX SMC to order documents from Standards and Methods Control, Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

For other documents listed above, contact the Training Group in Nijmegen (JGO).

14.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

PGA removal tool	Mark Eyelet Pet 1040
Automatic etch cutter	Automation Unlimited EC83
End mills	3/32-inch (2.38 mm) 2 flute - 1/8 shank 2 inch OAL
Populated module fixture	In-house design D-AD-9513185-00-0 (JGO)
Re-circulating solder waves (Choose one)	Air-Vac PCBRM10/Air-Vac PCBRM12 Electrovert Soldapak Wenesco M97A
Side 2 preheaters (Choose one)	Lindberg 53015 hotplate Infrared lamp kit (JGO) (B-DD-9309680-00-0 (JGO))
Side 1 preheat - If I/O is Over 144	Leister 3000
Oven preheating	Blue Memert
Materials	63/37 SnPb solder RMA flux (Alpha 611) 111-Trichlorethane or site-specified alternative, (Alpha 565) Solvent Freon TE-35 solvent Oil blanket (only used when compatible with cleaning process)

14.5 LIMITATIONS

Extreme care must be taken to calibrate the Automation Unlimited EC83 etch cutters surface sense mechanism so as not to contact FR4 with the end mill during the sensing operation.

14.6 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required.

CAUTION

End mill quality, etch cutter set up, wave height, module thickness, module flatness, process parameters, moisture content in the board, and operator training all play a vital role in the success of this process. Therefore, an understanding of each variable is absolutely necessary.

14.7 TRAINING AND SUPPORT

Training and support are available from TRG Training at Andover, MA (AET), Field Service Module Repair \Training Group in Andover, MA (DAS), and from the Training Group in Nijmegen, the Netherlands (JGO).

15 INSULATED CONTACT PIN AND SLEEVE PROCESS

15.1 INTRODUCTION

The process described here is only recommended for modules requiring inner layer etch cuts that can not be performed due to close etch to etch spacing. The Cmax XVMP module is the first such module requiring this process. The method requires automated etch cutting equipment, and the use of insulated contact pins or sleeves specifically designed for this process.

15.2 DESCRIPTION

On some modules it may be very difficult to isolate a damaged or unneeded connection without severing or nicking nearby etch lines on the same layer or other layers. The method described here provides an alternative to the etch cut procedure that allows the unwanted connection to be isolated while maintaining the original test points. Rather than cutting the etch line near the dispersion via or PTH, this method involves drilling out the via or PTH through the entire board thus severing all connections to that PTH or via. An insulated contact pin (for SMT devices) or an insulated contact sleeve (for through hole devices) is then press fit into the hole from side 2 of the module. The contact pin or sleeve provides a testable location and also provides a contact to which ECO wires can be soldered to restore the needed connections. The process can be used prior to or following module assembly. The flow described below is for assembled modules.

Process Flow	Recommended Equipment
• Identify Suspect vias	Test or ECO instructions
•Remove obstacle wires	Solder iron
•Remove obstacle devices	Tool based on device type
•Generate drill program	EC83 etch cutter
•Load proper tools	Drills
•Set up fixture	Populated board fixture
•Load and clamp board	Fixture
•Drill out PTH / vias	EC83 etch cutter
•Clear remains of pads	Countersink (manual)
•Gage hole diameters	Go/No-Go gages
•Replace and solder SMT device	Tool based on device type
•Load board on fixture	Support Fixture for insertion
•Press fit pins/sleeves	Insertion Tools
•Replace and solder TH device	Tool based on device type
•Solder wires to pins/sleeves	Solder iron and ECO wire
•Clean	Solvent
•Inspect	Microscope
•Test	In-circuit tester

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15.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up and operating procedure, refer to the documents listed here.

Document Identifier	Title
No number assigned	*Insulated Contact Pin and Sleeve Process*
A-MN-ELMF422-00-0	*Automated Etch Cutter Operator's Manual*

Use VTX SMC to order documents from Standards and Methods Control.
Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

15.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

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Automatic etch cutter	Automation Unlimited EC83
Auto tool changer(recommended)	Automation Unlimited
Spindle and Converter (recommended)	Precise FC62M Precise PVSF1
Fixture for drilling populated modules	In house design.
drills	0.0292-inch (0.7400 mm) diameter x 2½-inch (63.50 mm) long 0.0550-inch (1.400 mm) diameter x 2½-inch (63.50 mm) long
gages	Deltronic X series. Go .0280 .0550 No-Go .0296 .0578
Pin Insertion Tool	Concentric Tool Mfg. Co. 42010-2
Sleeve Insertion Tool	Concentric Tool Mfg. Co. 42010-1
Interchangeable Handle	Concentric Tool Mfg. Co. 42054
Support Fixture for Insertion	In house design.
Materials	Insulated Contact Sleeve 12-29560-00
	Insulated Contact Pin 12-29561-00
	ECO or repair wire adhesive 63/37 SnPb Solder RMA Flux (Alpha 611)

15.5 LIMITATIONS

The insulated contact pin is designed for boards with 0.020-inch (0.508 mm) diameter dispersion vias. For designs with smaller dispersion vias and two lines between vias on a 0.050-inch (1.270 mm) grid, the insulated pin cannot be used. In these cases, the connection can be severed by cutting the layer 1 dispersion etch between the SMT pad and the via, and then reforming the needed connections by soldering ECO wire to the SMT device lead. When this method is used, the test point is lost and a new test location must be identified.

15.6 EVALUATION

Hole diameters are to be inspected after drilling with Go/No-Go gages.

Visual examination under a microscope at 10X is required to inspect the soldered connections of ECO wires to insulated pins, sleeves, and SMT leads.

15.7 TRAINING AND SUPPORT

Training and support are available through the Training Department, Salem, NH (NIO).

16 50-MIL SURFACE MOUNT DEVICE REMOVAL AND REPLACEMENT 14 TO 84 PIN

16.1 INTRODUCTION

The 50-mil SMT device removal and replacement method, and the equipment defined here is the preferred method approved and supported by MPE/TRG. It is recommended for all modules that use 50-mil SMT components. This process has been tested and qualified on a variety of modules ranging from 0.062 inch (1.574 mm) to 0.147 inch (3.733 mm).

16.2 DESCRIPTION

The process defined here is applicable for any module containing 50-mil J-bend or gull wing SMT components that must be removed or replaced, regardless of which side they are mounted on. The repair equipment recommended for this task is a machine that uses hot air as the heat transfer medium. The equipment specified here provides control over the preheat temperature and time, the reflow temperature and time as well as the cool-down time. The machine listed here also provides the mechanics that allow the old device to be removed and a new device placed without relying on operator dexterity.

Process Flow	Recommended Equipment
• Identify suspect SMT device	Test or microscope
• Remove affected ECO and repair wires	Soldering iron
• Load module onto repair machine	Rework machine SRT or Gemtek Surmount is preferred. MES is an alternate machine.
• Change heater head and set parameters	Custom heads
• Flux device leads/footprint	RMA flux
• Align head over device	SRT or Gemtek is preferred. MES is an alternate machine.
• Apply bottom side preheat	SRT or Gemtek is preferred. MES is an alternate machine.
• Apply reflow air to device leads	SRT or Gemtek is preferred. MES is an alternate machine.
• Apply vacuum to remove device	SRT or Gemtek is preferred. MES is an alternate machine.
• Apply cooling air to bottom side	SRT or Gemtek is preferred. MES is an alternate machine.
• Apply additional flux to the pads	RMA flux

Process Flow	Recommended Equipment
• Apply additional solder to pads	Wire solder/iron
• Remove flux on board	Solvent/swab
• Place new flux on pads for re-attach	RMA flux
• Load new device into vacuum head	MES custom heads
• Align new device to existing footprint	SRT or Gemtek is preferred. MES is an alternate machine.
• Lower new device onto pads	SRT or Gemtek is preferred. MES is an alternate machine.
• Apply lower preheat	SRT or Gemtek is preferred. MES is an alternate machine.
• Apply top side reflow air	SRT or Gemtek is preferred. MES is an alternate machine.
• Apply lower side cooling air	SRT or Gemtek is preferred. MES is an alternate machine.
• Clean repaired area	Solvent
• Re-attach ECO and repair wires	Soldering iron
• Inspect	Stereo microscope with oblique viewing
• Touch up	Soldering iron/probe
• Test	In-circuit tester

16.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up and operating procedure, refer to the document listed here.

Document Identifier	Title
A-MN-ELMF417-01-0	*Surface Mount Technology Reference Manual -2 Volume Set*

Use VTX SMC to order documents from Standards and Methods Control.
Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

16.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

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Reflow equipment (SRT)	SRT - Sierra See SMT Equipment Matrix (Appendix B) for other acceptable equipment
Custom reflow heads	Gemtek machine, if used
Soldering iron	METCAL Sta Temp
Stereo microscope	Meiji, Wild, Parco or equivalent
Materials	ECO or repair wire 63/37 SnPb solder (paste or wire) RMA flux (Alpha 611) 111-Trichlorethane or site-specified alternative, (Alpha 565) solvent Freon TE-35 solvent Tex-swabs

16.5 LIMITATIONS

Extreme care must be taken to properly profile the thermal response of each module to assure that the joints created are as strong and reliable as the original product. It should be noted that unless your 68 and 84 PLCC are dry (refer to EL-MF417-01 for a definition of dry). The 68 and 84 PLCC packages must be re-attached using a soldering iron and not hot air. This is due to the component cracking problems with these devices. Refer to EL-MF417-00 for more information on PLCC cracking. The equipment described here is capable of removing 25-mil pitch SMT devices and reflowing them. The MES machine, Surmount I, is not the preferred machine because there are other features that are necessary to prevent misalignment. The features necessary for 25-mil removal and replacement are included on the SRT - Sierra or GEMTEK Challenger machine.

16.6 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required. Refer to *DEC STD 116-0 Workmanship Standards Manual* for solder joint criteria.

CAUTION

Operator training, properly designed heater heads, cleaned solderable components and boards, and a controlled process all play a vital role in the success of this process. Therefore, an understanding of each variable is absolutely necessary. It should be noted that the module, components and equipment remain very hot during this process. Care must be taken to minimize the risk of burns throughout the process. It should be noted also, that while a module is at elevated temperatures, it is very easy to lift a pad from a board by contacting it or pulling on a solder joint that has not completely reflowed.

16.7 TRAINING AND SUPPORT

Training and support are available from TRG Training at Andover, MA (AET), Field Service Module Repair \Training Group in Andover, MA (DAS), and from the Training Group in Nijmegen, the Netherlands (JGO).

17 25-MIL SURFACE MOUNT DEVICE REMOVAL AND REPLACEMENT 132 TO 224 PIN

17.1 INTRODUCTION

The 25-mil SMT device removal and replacement method and equipment defined here is the preferred method approved and supported by MPE/TRG. It is recommended as a fix for all modules that use 25-mil SMT components. This process has not been fully tested.

17.2 DESCRIPTION

The process defined here is applicable for any module containing 25-mil Gull Wing Cerquad or MLCC SMT components that must be removed or replaced, regardless of which side they are mounted on. The repair equipment recommended for this task is a machine that uses hot air as the heat transfer medium. The equipment specified here provides control over the preheat temperature and time, the reflow temperature and time and the cool-down time. The machine also provides the mechanics that allow the old device to be removed and a new device placed without relying on operator dexterity.

Process Flow	Recommended Equipment
•Identify suspect SMT device	Test or microscope
• Remove affected ECO and repair wires	Soldering iron
• Load module onto repair machine	Rework machine SRT - Sierra or Gemtek
• Change heater head and set parameters	Custom heads
• Flux device leads/footprint	RMA flux
• Align head over device	SRT - Sierra or Gemtek
• Apply bottom side preheat	SRT- Sierra or Gemtek
• Apply reflow air to device leads	SRT - Sierra or Gemtek
• Apply vacuum to remove device	SRT- Sierra or Gemtek
• Apply cooling air to bottom side	SRT- Sierra or Gemtek
• Apply additional flux to the pads	RMA flux
• Apply additional solder to pads A/R	Wire/paste/iron/preforms
• Remove flux on board	Solvent/swab
• Place new flux on pads for re-attach	RMA flux
• Load new device into vacuum head	SRT- Sierra or Gemtek
• Align new device to existing footprint	SRT- Sierra or Gemtek
• Lower new device onto pads	SRT- Sierra or Gemtek
• Apply lower preheat	SRT- Sierra or Gemtek
• Apply top side reflow air	SRT- Sierra or Gemtek
• Apply lower side cooling air	SRT- Sierra or Gemtek
• Clean repaired area	Solvent
• Re-attach ECO and repair wires	Soldering iron
• Inspect	Stereo microscope
• Touch up	Soldering iron/probe
• Test	In-circuit tester

17.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up, and operating procedure, refer to the document listed here.

Document Identifier	Title
A-MN-ELMF417-01-0	*Surface Mount Technology Reference Manual -2 Volume Set*

Use VTX SMC to order documents from Standards and Methods Control,
Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

17.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

Reflow equipment (preferred)	SRT - Sierra. See SMT Alternate Equipment Matrix (Appendix B) for other acceptable equipment
Soldering iron	METCAL Sta Temp
Stereo microscope	Meiji, Wild, Parco or equivalent
Materials	ECO or repair wire 63/37 SnPb solder (paste or wire) RMA flux (Alpha 111-Trichlorethane) or site-specified alternative, (Alpha 565) solvent Freon TE-35 Solvent Tex-swabs Preforms if used (Raychem)

17.5 LIMITATIONS

Extreme care must be taken to properly profile the thermal response of each module to assure that the joints created are as strong and reliable as the original product.

17.6 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required. Refer to *DEC STD 116-0 Workmanship Standards Manual* for solder joint criteria.

CAUTION

Operator training, properly designed heater heads, cleaned solderable components and boards, and a controlled process all play a vital role in the success of this process. Therefore an understanding of each variable is absolutely necessary. It should be noted that the module, components and equipment remain very hot during this process. Care must be taken to minimize the risk of burns throughout the process. It should be noted also, that while a module is at elevated temperatures, it is very easy to lift a pad from a board by contacting it or pulling on a solder joint that has not completely reflowed.

17.7 TRAINING AND SUPPORT

Training and support are available from TRG Training at Andover, MA (AET), Field Service Module Repair \Training Group in Andover, MA (DAS), and from the Training Group in Nijmegen, the Netherlands (JGO).

18 SMT PAD AND OUTER LAYER ETCH REPLACEMENT PROCESS (Proprietary Process)

18.1 INTRODUCTION

The SMT pad and outer layer etch replacement method and equipment defined here is the preferred method approved and supported by Salem Module Repair and MPE/TRG. It is recommended as a fix for any module with pads or surface etched features that have been removed accidentally. This process has been tested and qualified on a variety of pad sizes and etch lines.

18.2 DESCRIPTION

The process defined here is applicable for any module containing surface etch, SMT pads, or other features that have been damaged, removed, or lifted from the surface of the board. The repair equipment recommended for this task is a special bonding press with tips designed for each feature being repaired. Heat used with pressure and specially prepared adhesive backed replacement pads and etch are all critical components of the process. The equipment and materials specified here provide control over the bonding time, temperature and pressure, the adhesive layer thickness. Although the equipment required is inexpensive and simple to use, the skill in terms of operator dexterity, is very important and must be considered.

Process Flow	Recommended Equipment
• Identify suspect SMT device	Test or microscope
• Remove damaged SMT pad or etch line	Soldering iron / X-Acto knife
• Clean local area	Solvent
• Lift self-adhesive pad from pad overlay	Custom pad overlay/X-Acto knife
• Place pad or etch feature onto board	Under microscope
• Contact pad/etch with soldering iron	METCAL iron
• Apply heat and pressure to new pad/etch	Bonding press contact welder
• Remove protective coating from new pad	Solvent
• Flux new pad or surface feature	RMA flux
• Tin the new pad with 63/37 solder	63/37 SNPB solder
• Clean repair local area	Solvent
• Perform continuity check	Continuity checker
• Submit to inspection	Microscope and continuity checker
• Reattach ECO/repair wires, component	Soldering iron or other
• Test	In-circuit tester

18.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up, and operating procedure refer to A-SP-ELMF362-00-0, *Etch Repair Procedures*.

Use VTX SMC to order documents from Standards and Methods Control.
Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

18.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

Contact heater press (welder)	Consult author
Custom contact bonding tips	Consult author
Soldering iron	METCAL Sta Temp
Stereo microscope	Meiji, Wild, Parco or equivalent materials
Protective coating solvent	
ECO or repair wire	
63/37 SnPb solder (paste or wire)	
RMA Flux (Alpha 611)	
111-Trichlorethane or site-specified alternative, (Alpha 565) solvent	
Freon TE-35 solvent	

18.5 LIMITATIONS

Extreme care must be taken to properly align and connect the new pad with the original board. Longer surface etch lines are more difficult to repair and may require more than one cycle to repair. For accurate pad layer duplication a custom self-adhesive pad-layer sheet should be produced for each module.

18.6 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required. Refer to *DEC STD 176-0 Printed Wiring Board Acceptance Criteria*.

CAUTION

Operator training, properly designed heater tips, clean surfaces, consistent quality pad-layer overlay sheets, and a controlled process all play a vital role in the success of this process. Therefore, understanding each variable is absolutely necessary.

18.7 TRAINING AND SUPPORT

Training and support are available from the Module Repair Group, Salem, NH (NIO) and Customer Repair Training Group at Andover, MA (DAS).

19 ETCH CUTTING PROCESS

19.1 INTRODUCTION

The etch cutting process defined here is considered a last resort to repairing modules that exhibit inner-layer shorts or opens. Depending on the technology of the module being repaired or reworked, there are three different tools available. Each method is best suited for a certain module density. All three of these processes are approved and supported by MPE/TRG. These processes have been tested and qualified on a variety of modules that encompass the entire spectrum of Digital modules.

19.2 DESCRIPTION

The process defined here is applicable for any module containing surface etch, or inner-layer etch that must be isolated to disconnect an unwanted signal connection or electrical short. The three repair tools and their recommended applications are listed here. Generally modules that use controlled impedance circuits require these signals to be cut in two places (within 0.250 inch from the point of connection) to avoid the antenna effect. The automated etch cutter specified here provides control over the depth, diameter/width, length, and location of each etch cut, where the hand held power tool and X-Acto knife depend on operator skill and dexterity for the end result. The recommended end mill diameter is 0.020 inch, but this may vary, based on the line width of the etch and clearances.

Table 6: Etch Cutting Tool Matrix

Board Technology	X-Acto Knife	Hand-Held Power Tool	Automated Etch Cutter
		Cutting Tool	
SD (20/20)(Outer layers)	Acceptable	Recommended	Recommended
HD1(15/15)(Outer layers)	Acceptable (Not recommended)	Acceptable	Recommended
HD2(12/13)(Inner layers)	Acceptable (Not recommended)	Acceptable	Recommended
HD1(15/15)(Inner layers)	Acceptable (Not recommended)	Acceptable (Not recommended)	Recommended
HD2 (12/13)(Inner layers)	Acceptable (Not recommended)	Acceptable (Not recommended)	Recommended
FL1 (8/8)	Acceptable (Not recommended)	Acceptable (Not recommended)	Recommended
FL2 (6/10 - MSL)	Acceptable (Not recommended)	Acceptable (Not recommended)	Recommended
FL3 (6/10 - MSL VAXBI and SMT)	Acceptable (Not recommended)	Acceptable (Not recommended)	Recommended
FL4 (5/5)	Acceptable (Not recommended)	Acceptable (Not recommended)	Recommended

Process Flow (for Auto-Etch Cutter)	Recommended Equipment
• Identify suspect signal or short	Test
• Determine endpoints of signal	50 Class Print/Electronic Data VLS or Vantage can be used to determine endpoint.
• Determine both cut coordinates	XYZ W 1 to 1 Mylar or electronic data. VLS ILR or DLRS can be used
• Determine obstacle components	Visual inspection
• Inch support pin locations (populated)	Visual inspection while on the EC83
• Inch surface sense / marker location	Visual inspection while on the EC83
• Generate bare and populated program	C60 controller on etch cutter or MSLPMS software in combination with EC83 XYZ Compensation Software
• Set-up tooling pins	EC83 fixturing
• Load module on EC83	EC83
• Down line load file to C60 or insert microcasette	C60 OF EC83
• Perform surface sense	Puck
• Perform marker cut	End mill 0.020 inch (0.508 mm) recommended
	NOTE **The end mill diameter is normally 0.20 inch (0.508 mm), but this may vary, based on the line width and line spacing, especially for MSL 5/5 technology modules. Refer to related documentation.**
• Perform etch cut	EC83 with vacuum
	NOTE **This may vary, based on the MSL Technology. In case of any doubt, refer to related documentation.**
• Perform clean out cut	EC83 with vacuum
• Check for continuity	Continuity checker CMOS safe
• Submit to inspection	Microscope
• Reconnect signal A/R with twisted wire pair or 30 AWG wire	Soldering iron (METCAL)
• Check nearby signals at risk	Continuity checker and VLS, DLRS support
• Test	ICT or diagnostic

19.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, programming guide, and equipment set up and operating procedure, refer to the documents listed here.

Document Identifier	Title
A-MN-ELMF422-00-0	*Automated Etch Cutter Operator's Manual*
A-RE-MSLECUT-00-JG00	*CSL MSL XYZ Etch Cutter Operator Manual*
A-RE-MSLECUT-00-JG01	*CSL MSL XYZ Etch Cutter Engineering Manual*
A-RE-EC83COMP-00-JG00	*EC83 XYZ Etch Cutter Compensation Software*
A-RE-VLSILR-00-JG00	*VLS ILR (Inner Layer Etch Repair) Manual*
A-ME-VLSUSER-00-JG00	*VLS Read/Only User Manual*
A-ME-VLSGLOS-00-JG00	*VLS Glossary of Terms*
A-RE-MSLECS-00-JG00	*Multisignal Layer Equipment Control System Manual*
A-RE-MSLPLMS-00-JG00	*Multisignal Layer Pattern Library Management System Manual*
A-PG-MSLECUT-00-JG00	*EC83 XYZ Etch Cutter Process Guide*
A-RE-VLSXYZ-00-JG00	*VLS XYZ Inner Layer Etch Repair Manual*
A-AS-MSLECS-00-JG00	*EC83 XYZ Software Installation Manual*
A-RE-VLSILR-00-JG01	*VLS ILR Default Parameter Settings*

Use VTX SMC to order documents from Standards and Methods Control.
Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

19.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

X-ACTO KNIFE METHOD (See matrix for applicability)

NOTE

Double cuts are required. Remove etch between the cuts 0.1-inch to 0.5-inch maximum cut width. Peel back or heat assisted removal methods are recommended.

X-Acto Knife	Assortment of Blades
Continuity checker	Contact East (zero beeper)

HAND-HELD POWER TOOL METHOD (See matrix for applicability)

NOTE

Double cuts are required. Remove etch between the cuts 0.1 inch (2.54 mm) to 0.5-inch (12.70 mm) maximum cut width. Peel back or heat assisted removal methods are recommended.

Rotary Tool (Choose one)	Dremel No. 3801 Starlite air grinder No. 501005 Pace PRC 150-A benchtop repair station
Magnifier	Luxo LFM1/A 4,6 or 8 diopter
Cutting tool (bit)	Dentist No. 2 carbide burr-straight Handpiece-ss white Pennwalt Starbide drill No. 418005 0.025-inch (0.635 mm) head diameter Pace fine cutting tool No. PM-166 Pace ball mill No. 11112-0001 0.016 inch (0.406 mm) diameter
Stereo microscope	Meiji, Wild, Parco or equivalent

19.5 ETCH CUTTING PROCESS LIMITATIONS

These processes are qualified and approved for modules using up to MSL 6/8 technology.

MSL 5/5 technology requires additional fixturing or changes in the process to achieve the same results.

19.6 AUTOMATION UNLIMITED ETCH CUTTING METHOD

(Surface etch and inner layer etch.)

Refer to the vendor and ordering section in , A-MN-ELMF422-00-0 *Automated Etch Cutter Operator's Manual* and A-PG-MSLECUT-00-JG00 *EC83 XYZ Etch Cutter Process Guide*, for a complete listing of equipment and tools required for automated etch cutting process.

19.7 PRIMARY EQUIPMENT

Automation Unlimited EC83 Etch Cutter
D-AD-9513185-0-0 *EC83 Uni-fixture Populated Boards*

19.8 LIMITATIONS

If the manual etch cutting method is used, extreme care must be taken not to cut too deep into the module or accidentally cut neighboring traces. If automatic etch cutting is used, the set up and calibration of the machine's surface-sense hardware is essential for accuracy. These processes are qualified and approved for modules using up to 6/10 technology; 5/5 technology may require additional fixturing or changes in the process to achieve the same results.

19.9 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required.

CAUTION

Operator training, equipment calibration, clean work areas, and strict adherence to the process all contribute to a safe operation. This process requires operators to wear safety glasses. If the hand-held power tool method is used, operators in the same vicinity shall be required to wear safety glasses. If the heat-assisted method of removing the signal between manual etch cuts is in use, be certain not to overheat the board. Overheating a module will cause delamination and blistering.

19.10 TRAINING AND SUPPORT

Training and support are available from TRG Training at Andover, MA (AET), Field Service Module Repair \Training Group in Andover, MA (DAS), and from the Training Group in Nijmegen, the Netherlands (JGO ECN).

20 FINE LINE (0.008 INCH AND SMALLER) SURFACE AND INNER LAYER ETCH REPLACEMENT AND GOLD CONTACT KOVAR RIBBON PROCESS

20.1 INTRODUCTION

The inner layer etch replacement method and equipment defined here is the preferred method. It has been approved and supported by MPE/TRG. It is recommended for any module with fine line surface or inner-layer opens that can be exposed and repaired without causing damage to the signal lines that are located near the etch line in question. It is also the preferred method of connecting to a gold contact on a module. This process has been tested and qualified on a variety of line sizes on a variety of module types.

20.2 DESCRIPTION

The process defined here is applicable for any module containing open fine line surface or inner-layer etch caused by internal delamination, stress induced damage, or mechanical forces. The process and tools outlined here are also used to create or reconstruct connections to the gold contact area of the board. The repair equipment recommended for this task is a special gap welder capable of welding very small parts. This method is the preferred method of repairing modules exhibiting this type of failure. The method described here utilizes various shaped gap welder tips (some custom made) to bond the various widths of Kovar wire to the damaged trace.

Process Flow (for Auto-Etch Cutter)	Recommended Equipment
• Identify suspect open	Test or microscope
• Remove damaged section of etch line	Soldering iron, X-Acto knife
• Clean local area	Solvent
• Locate and precut Kovar ribbon length	X-Acto knife
• Power up welder	Hughes welder 150
• Place Kovar ribbon and overlap break	Kovar ribbon
• Weld ribbon in place	Hughes welder
• Repeat for other end of connection	Hughes welder
• Clean repair local area	Solvent
• Check for continuity	Low voltage continuity checker
• Submit to inspection	Microscope/continuity checker
• Test	In-circuit tester

20.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up and operating procedure, refer to the documents listed here.

Document Identifier	Title
A-SP-ELMF362-00-0	*Etch Repair Procedures*

Use VTX SMC to order documents from Standards and Methods Control.
Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

20.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

Contact heater (welder)	Hughes welder 150
Custom contact bonding tips	As required
Soldering iron	METCAL Sta Temp
Stereo microscope	Meiji, Wild, Parco or equivalent
Materials	Solvent, Kovar ribbon, 111-Trichlorethane or site-specified alternative, (Alpha 565) solvent, Freon TE-35 solvent

20.5 LIMITATIONS

Extreme care must be taken to properly align and connect the Kovar ribbon with the original etch. Longer surface etch lines are more difficult to repair and may require more than one cycle to repair. If Kovar ribbon is not available in the dimensions you need, a custom self-adhesive etch-layer sheet should be produced for each module.

20.6 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required. Refer to *DEC STD 176-0 Printed Wiring Board Acceptance Criteria*.

CAUTION

Operator training, properly designed heater tips, clean surfaces, consistent quality pad-layer overlay sheets, and a controlled process all play a vital role in the success of this process. Therefore, understanding each variable is absolutely necessary.

20.7 TRAINING AND SUPPORT

Available through the Module Repair Group in Salem, NH (NIO), and the Field Service Module Repair / Training Group at Andover, MA (DAS).

21 THROUGH HOLE COMPONENT TO COMPONENT WIRE ADD (SOLDERING/BONDING) PROCESS RULES

21.1 INTRODUCTION

The wire add rules listed here define preferred methods and practices approved and supported by MPE/TRG. Unless specifically noted in an ECO document, these rules should be regarded as the only acceptable method to add, secure, terminate, and remove wires to or from modules. This section does not apply to twisted-pair wire adds, nor will it address wire adds to surface mount products. This process has been tested and qualified on a variety of line sizes on a variety of module types.

21.2 DESCRIPTION

The process rules defined here are applicable for any module containing open inner-layer or outer-layer etch. Wire adds are considered acceptable in terms of replacing opens or making modifications to boards, but they are not allowed when soldered to etch lines of 0.008 inch or less. When etch lines 0.008 inch or less in width are damaged, they can only be repaired (corrected) by using a parallel gap welding station and Kovar wire as defined in *Etch Repair Procedures*, EL-MF362-00 . If the welding process is not feasible, the only other method is to isolate the open by the etch cut process and add wires as defined in this section.

Process Flow	Recommended Equipment
• Identify open or wire add location	Test or microscope
• Isolate open with etch cuts A/R	Manual or automatic etch cutter
• Measure wire length: green = ECO, white = repair	Scale
• Cut wire to match desired length	Wire cutters
• Strip insulation on both ends	Stripping tool
• Check wire for nicks	Visual inspection
• Pre-tin both ends of wire	Soldering iron and 63/37 solder
• Form wire	Nonmetallic forming tool
• Solder one end of wire a. Straight through component hole b. Lap solder to lead c. 1 loop around component lead	Soldering iron
• Route wire to complete connection	Visual / Logpont machine
• Bond wire per rules listed here	Adhesive (see Matrix)
• Solder second end of wire	Soldering iron
• Check for continuity	Contact East (zero beeper)
• Clean local area	Freon or 111-Trichlorethane or site-specified alternative

An automated wire add machine called the Logpoint Machine, which uses a pair of light beams projected at the module being repaired and highlights the end points for wire adds, defines routing, and indicates continuity checkpoints automatically.

THROUGH HOLE LEAD-TO-LEAD WIRE ADD RULES

- Use 30 AWG green Kynar wire for wires added in the ECO process.
- Use 30 AWG white Kynar wire for wires added in order to repair opens
- All white wires must be routed so as to duplicate the original routing used on the raw board.
- All wires must be soldered and routed to Side 1 of the module unless the pins are not accessible from Side 1.
- If the wires have been added prior to wave solder, they may only be routed on Side 1 of the module.
- If the wires are added to Side 1 prior to wave solder, the only approved adhesive for bonding the wire to the module is Loctite high viscosity black max. See Matrix for part number details.
- When bonding wires to Side 1 of a module, adhesive is required at every change of direction as well as at two-inch intervals along the path.
- Wires added to Side 1 with lengths 0.5 inch (12.7 mm) or less need not be bonded. Refer to DEC STD 116-0.
- When bonding wires added to a module on Side 2 (allowed only after wave soldering), adhesive must be applied at each change of direction and at one-inch intervals along the path.
- When routing wires to a module avoid sharp bends that could stress the wire and cause the bonds to fail or the wire to crack. A good rule is to keep the bend radius greater than three times the diameter of the wire itself.
- Wire adds must not be run any closer than 0.250 inch from the nearest edge of a module to not obstruct its ability to slide into the card tray.
- When adding wires to adjacent pins on a component, a loop should be formed so that the wire add can be seen easily.
- If the uninsulated portion of a wire is run over a signal that is covered with soldermask, care should be taken to prevent it from shorting out other nearby connectives.
- The stripped portion of a wire add should only be what is needed to make a strong connection. Excess, stripped wire may short out nearby connections. Care is required to eliminate this situation.
- Wire insulation is not permitted to touch the solder joint. If insulation is accidentally introduced into the joint the solder should be wicked up and new wire added.
- Inspection by pulling on the wire to test the strength is NOT ALLOWED, it will degrade the bond being tested.
- All wires shall be installed by soldering the wire into a PTH or a through-hole via where ever possible. Connections made to a component lead are considered a secondary technique.

21.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up and operating procedure, a document will be made available later.

21.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

ECO wire (green)	Kynar 30 AWG
Repair wire (white)	Kynar 30 AWG
Soldering iron	METCAL Sta Temp
Stereo microscope	Meiji, Wild, Parco or equivalent
Continuity checker	Contact East (zero beeper)
Solder	63/37 solder wire
Flux	RMA type Alpha 611 F
Solvent	111-Trichlorethane or site-specified alternative, (Alpha 565)
Freon TE-35 solvent adhesive	Loctite black max or HV black max.

Table 7: Circuit Width versus Wire Gauge

Circuit Width		
inch	mm	Wire Gauge (AWG)
0.005	0.13	PTH to PTH or Kovar ribbon
0.008	0.20	30
0.012	0.31	30
0.015	0.38	30
0.030	0.76	30
0.050	1.27	28
0.075	1.90	26
0.100	2.54	24
0.150	3.81	22
0.200	5.08	20
0.250	6.35	20

21.5 AFTER WAVE SOLDER

Any of the following adhesives can be used when wires are bonded after wave solder or in a repair operation.

Description	Part Number
Loctite 414 Adhesive	Digital part number 49-01272-00
Loctite 420 Adhesive	Digital part number 90-09157-01
Loctite Tak Pak Kit	Digital part number 49-01259-00
Loctite Elastomer Bond	Digital part number not available
Adhesive	Loctite P/N 76826
Loctite HV Tough	Digital part number not available
Black max No. 410	Loctite P/N 12876 or 77
Loctite black max	Digital part number not available
Non HV No. 380	Loctite P/N 352 UV core
Loctite surface insensitive gel	Digital part number 49-0187501

NOTE

All of the above adhesives may be used with Loctite Tak Pak accelerator. Only the HV Tough adhesive requires application of the accelerator after the adhesive is applied. In using all other adhesives, apply the accelerator to the board surface prior to applying the adhesive.

21.6 ADHESIVE STORAGE

The shelf life of Loctite adhesive products is 12 months with the exception of HV Tough adhesive, which has a shelf life of six months. To maximize shelf life, it is recommended that the adhesives be refrigerated (40°F to 45°F [100°C to 110°C]) during storage. It is also recommended that accurate adhesive use be determined to minimize the risk of storing adhesives that are beyond their shelf life. It should be noted that Loctite will set up a drop-ship program with plants so that "fresh" adhesives are automatically delivered every month to cover a projected use.

21.7 ADHESIVE REMOVAL

When it is necessary to remove adhesive from a board surface, use Loctite X-NMS Clean-Up Solvent. A cotton swab or similar applicator should be used to avoid extensive contact with skin. Note that this solvent may deteriorate some plastics (for example, handles) on boards. Therefore, operators should not permit solvent to come in contact with plastics. Do not allow adhesives to contact any surface (for example, lead, pad, or circuit) that will be required to accept solder. If this occurs, apply Loctite X-NMS solvent to remove adhesive from surface.

Adhesive dispenser systems should be used to aid adhesive application. Loctite Bond-A-Matic 2000, Model 200 and Electron Fusion Devices (EFD) Model 2000DV are recommended. Always follow manufacturer's safety and operational specifications when operating this equipment.

21.8 WIRE REMOVAL

The preferred method of removing wires from a module is described in the following steps.

1. Heat the connection and remove the solder from the wire termination (both ends).
2. If the wire has been bonded, carefully apply Loctite X-NMS adhesive remover to the adhesive. A cotton swab or similar applicator should be used to prevent excessive contact of remover with skin. Repeated applications may be required to completely remove the adhesive from the board.

NOTE

Loctite X-768NMS, Digital part number 49-01678-01 is the only adhesive remover currently recommended for the removal of cyanoacrylate. Note that this solvent may deteriorate some plastics (for example, handles) on boards. Therefore, operators should not permit solvent to come in contact with plastics.

3. After applying the adhesive remover, carefully lift the wire from the board.
4. Remove the wire at both ends. Resolder the connection if there is a component lead/wire still in the hole.
5. Clean the connections that have been resoldered using the approved cleaning method. Refer to subhead 3.2.

If it is necessary to remove wires from a board, but to do so would damage the module or components, it is allowable to cut the wire ends and leave the rest of the wire in place.

CAUTION

Do not cut wires so that the exposed ends will create a potential electrical short circuit. If possible, it is preferable to pull the bare wire from its insulation, leaving the insulation on the module.

21.9 LIMITATIONS

The manual tack soldering process for repairing a damaged etch run/connection on a printed wiring board is limited to etch lines larger than 0.008 inch (0.203 mm) in width only. For etch lines 0.008 inch (0.203 mm) and smaller, welding Kovar wire is the only recommended method of repair at this time.

21.10 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required. Refer to *DEC STD 176 Printed Wiring Board Acceptance Criteria* and *DEC STD 116-0 Workmanship Standards Manual* for acceptable versus unacceptable conditions.

CAUTION

Operator training, properly designed soldering irons, clean surfaces, and a controlled process all play a vital role in the success of this process, therefore, understanding each variable is absolutely necessary. Extreme care must be taken to avoid overheating the reworked area, since internal board and component damage will occur.

21.11 TRAINING AND SUPPORT

Available through the TRG Training Group, Field Service Module Repair / Training Group in Andover, MA (DAS), and Nijmegen, the Netherlands (JGO), and the Training Department, Salem, NH (NIO).

22 SMT COMPONENT-TO-COMPONENT WIRE-ADD PROCESS RULES FOR SOLDERED WIRE ADDS ONLY

22.1 INTRODUCTION

The Wire Add rules listed below define preferred methods and practices approved and supported by MPE/TRG. Unless specifically noted in ECO document, these rules should be regarded as the only acceptable method to add, secure, terminate and remove wires to or from modules.

This section does not apply to twisted-pair wire adds, nor will it address wire adds to through-hole products.

The process described here has been tested and qualified on a variety of line sizes on a variety of module types.

22.2 DESCRIPTION

The process rules defined here are applicable for any module containing open inner-layer or outer-layer etch. Wire adds are considered acceptable in terms of replacing opens or making modifications to boards, but they are not allowed when tack soldered to etch lines of 0.008 inch (0.20 MM) or less. When etch lines 0.008 inch (0.20 MM) or less in width are damaged, they can be repaired only by using a parallel gap welding station and Kovar wire as defined in EL-MF362-00 *Etch Repair Procedures* . If the welding process is not feasible, the only other method is to isolate the open by way of the etch cut process and add wires as defined below.

Process Flow	Recommended Equipment
• Identify open or wire add	Test or microscope location
• Isolate open with etch cuts A/R	Manual or automatic etch cutter
• Measure wire length: green = ECO, white = repair	Scale
• Cut wire to match desired length	Wire cutters
• Strip insulation on both ends	Stripping tool
• Check wire for nicks	Visual inspection
• Pre-tin both ends of wire	Soldering iron and 63/37 solder
• Form wire	Nonmetallic forming tool
• Solder one end of the wire	Soldering iron
• Straight through component hole	
• Lap solder to lead	
• One loop around component lead	
• Route wire to complete connection	Visual
• Bond wire per rules listed below	Adhesive (see Matrix)
• Solder second end of wire	Soldering iron
• Check for continuity	Zero beeper tester
• Clean local area	Freon or 111-Trichlorethane or site-specified alternative, TB

An Automated wire-add machine called the Logpoint Machine utilizes a pair of light beams projected at the module being repaired to highlight end points for wire adds, defines

routing, and indicates continuity checkpoints automatically. Refer to EL-MF413-00*Logpoint Operator's Manual* for more information on the Logpoint Machine (LYNX by EPE).

SMT COMPONENT LEAD-TO-LEAD WIRE-ADD RULES

- Must use 30 AWG green Kynar wire for wires added in the ECO process.
- Must use 30 AWG white Kynar for wires added in order to repair opens.
- All white wires should be routed to duplicate the original routing used on the raw board.
- All wire adds should be applied after mass reflow and after the solder-in-place process (for 25-mil SMT).
- When bonding wires to Side 1 of a module, adhesive is required at every CHANGE OF DIRECTION AS WELL AS AT 2.0-inch (50.80 mm) intervals along the path.
- When bonding wires added to a module on Side 2 (allowed only after wave soldering, mass reflow and solder in place), adhesive must be applied at each change of direction and at 1.0-inch (25.40 mm) intervals along the path.
- When routing wires to a module, avoid sharp bends that could stress the wire and cause the bonds to fail or the wire to crack. Keep the bend radius greater than three times the diameter of the wire.
- Wire adds must not be any closer than 0.250 inch (6.35 mm) from the nearest edge of a module so as not to obstruct its ability to slide into the card tray.
- When adding wires to adjacent pins on a component, a loop should be formed so the wire add can be seen easily.
- If the uninsulated portion of a wire is run over a signal that is covered with soldermask, care must be taken to prevent it from shorting out.
- The stripped portion of a wire add must be only what is needed to make a strong connection. Excess stripped wire may short out nearby connections. Care is required to avoid this situation.
- Wire insulation is not permitted to touch the solder joint. If insulation is accidentally introduced into the joint, the solder should be wicked up and new wire added.
- Inspection by pulling on the wire to test the strength is NOT ALLOWED since it will degrade the bond being tested.
- No more than two wires are allowed on any SMT component pin.
- Wires added to SMT components should follow the formation of the lead. Insulation must be positioned at the board and the stripped portion of the wire should follow the lead upward.
- Wires are not allowed to run over other components.
- Excess epoxy must NOT contact adjacent SMT leads and MUST BE AVOIDED or major physical damage could occur during SMT component removal.

22.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up and operating procedure refer to the documents listed below.

Formal documents do not exist. However, some internal site-specific documents may be available.

22.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

ECO wire (Green)	Kynar 30 AWG
Repair wire (White)	Kynar 30 AWG
Soldering iron	METCAL Sta Temp
Stereo Microscope	Meiji, Wild, Parco or equivalent
Continuity checker	Contact East (zero beeper)
Solder	63/37 Solder wire
Flux	RMA Type Alpha 611 Flux
Solvent	111-Trichlorethane or site-specified alternative, (Alpha 565) Freon TE-35 solvent
Adhesive	Loctite black max or HV black max

22.5 LIMITATIONS

The manual tack soldering process for repairing a damaged etch run / connection on a printed wiring board is limited to etch lines larger than 0.008 inch (0.203 mm) in width only. For etch lines 0.008 inch (0.203 mm) and smaller, welding Kovar wire is the only recommended method of repair at this time.

22.6 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required. Refer to *DEC STD 176-0 Printed Wiring Board Acceptance Criteria* and *DEC STD 116-0 Workmanship Standards Manual* for acceptable and non-acceptable conditions.

CAUTION

Operator training, properly designed soldering irons, clean surfaces, and a controlled process all play a vital role in the success of this process. Therefore, understanding each variable is absolutely necessary. Extreme care must be taken to avoid overheating the reworked area, since internal board and component damage will occur.

22.7 TRAINING AND SUPPORT

Training and support is available through the TRG Training Group, Field Service Module Repair / Training Group in Andover, MA (DAS), Nijmegen, the Netherlands (JGO), and the Training Department, Salem, NH (NIO).

23 TWISTED-PAIR WIRE-ADD PROCESS RULES

23.1 INTRODUCTION

The Twisted Pair Wire Add rules listed here define preferred methods and practices approved and supported by MPE/TRG. Unless specifically noted in an ECO document, these rules should be regarded as the only acceptable method to add, secure, terminate, and remove twisted-pair wires to or from modules.

23.2 DESCRIPTION

The process rules defined here are applicable for any module containing open inner-layer or outer-layer etch. Wire adds are considered acceptable in terms of replacing opens or making modifications to boards but they are not allowed when tack soldered to etch lines of 0.008 inch (0.203 mm)or less. When etch lines 0.008 inch (0.203 mm) or less in width are damaged they can be repaired (corrected) by using a parallel gap welding station and Kovar wire as defined in EL-MF362-00 *Etch Repair Procedures*. If the welding process is not feasible, the only other method is to isolate the open by way of the etch cut process and add wires as defined here.

Process Flow	Recommended Equipment
• Identify open or wire add	Test or microscope location.
• Isolate open with etch cuts A/R.	Manual or automatic etch cutter
• Measure wire length	Scale
• Cut wire to match desired length +2.5 inches. Allow enough for both signal and ground.	Wire cutters
• Strip insulation on both ends of the wire.	Stripping tool
• Check wire for nicks	Visual inspection
• Pre-tin both ends of the wire	Soldering iron and solder 63/37
• Perform a continuity check (both wires)	Continuity checker
• Form wire	Nonmetallic forming tool
• Solder one end of both wires Straight through component hole Lap solder to lead One loop around component lead	Soldering iron
• Route wire to complete connection	Visual
• Bond the wire according to the rules listed below.	Adhesive (see Matrix)
• Solder second end of wire	Soldering iron
• Check for continuity	Zero beeper continuity tester
• Clean local area	Freon or 111-Trichlorethane or site-specified alternative TB

A manually assisted wire add machine called the Logpoint Machine utilizes a pair of light beams projected at the module being repaired to highlight end points for wire adds, defines routing, and indicates continuity checkpoints automatically. Refer to EL-MF413-00 for more information on the Logpoint Machine (LYNX by EPE).

TWISTED-PAIR WIRE-ADD RULES

- All twisted-pair wire adds must follow the color coded scheme listed here.
- All wires must be routed to duplicate the original routing used on the bare board, or as specified in the rework instructions.
- All wires will be added to Side 1 (component side) unless otherwise specified.
- All wires shall be installed by soldering the wire into a plated-through hole (PTH) (or a through-hole via) whenever possible. Connections made to component leads are considered a secondary technique.
- ECL TWP wires are only required when the wire length is 1.0 inch (25.40 mm) or more. Single wire is used for lengths less than 1.0 inch (25.40 mm).
- TTL TWP wires are only required when the wire length is 5.0 inches (101.6 mm) or more. Single wire is used for lengths less than 5.0 inches(101.6 mm).
- TTL clock wires are required only when the wire length is 2.0 inches (50.80 mm) or more. For TTL clock runs less than 2.0 inches (50.80 mm), single wire is acceptable.
- The proper length of wire should be specified as part of the rework instructions. However, when it is necessary to repair an open clock signal on or in a module, the following rules apply when calculating the proper length of wire to use.

  If the signal is contained on an outer layer, the length of the TWP wire must be EQUAL to the etch run.

  If the signal runs internal to the module, the length of TWP wire needed to reconnect that signal is calculated by multiplying the original internal etch length by a factor of 1.3.

  If the signal is partially contained internally and on the outer layers of the board, the wire length is calculated by combining the steps outlined above. External length plus 1.3 times the internal length equals TWP wire run length.
- All wire adds should be applied after mass reflow and after The solder-in-place process (for 25-mil SMT) unless the wire is attached to an insulated pin.
- Side 1 TWP wires added to insulated pins should be tack soldered prior to wave solder. If these wires terminate on Side 2, the Side 2 termination is completed only after wave solder to avoid destroying them during the wave solder process.
- When bonding wires to Side 1 of a module, adhesive is required at every change of direction as well as at two-inch intervals along the path.
- When bonding wires added to a module on Side 2 (allowed only after wave soldering, mass reflow and solder in place), adhesive must be applied at each change of direction and at one-inch intervals along the path.
- When routing wires to a module, avoid sharp bends that could stress the wire and cause the bonds to fail or the wire to crack.
- The rule is to keep the bend radius greater than three times the diameter of the wire.
- The wire adds must not be run any closer than 0.250 inch (6.35 mm) from the nearest edge of a module. Do not obstruct its ability to slide into the card tray.
- When adding wires to adjacent pins on a component, a loop should be formed so that the wire add can be seen easily.

- If the uninsulated portion of a wire is run over a signal that is covered with soldermask, care must be taken to prevent it from shorting out.
- The stripped portion of a wire add must be only what is needed to make a strong connection. Excess stripped wire may short out nearby connections. Care is required to eliminate this situation.
- Wire insulation is not permitted to touch the solder joint. If insulation was accidentally introduced into the joint, the solder must be wicked up and new wire added.
- Inspection by pulling on the wire to test the strength is NOT ALLOWED, since it will degrade the bond being tested.
- For ECL wires, no more than two wires are allowed on any component hole/pin.
- For TTL wires, no more than three wires are allowed on any component hole/pin.
- No more than three wires are allowed at a ground hole.
- Do not route TWP wires adjacent to each other for more than 12 inches (304.8 mm).
- All ECO wires must be connected in a daisy chain fashion.
- ECL TWP wire sleeves shall be removed no more than 1.0 inch (25.40 mm) (the sum of the ground and signal wire lengths) from the last twist.
- The ground wire in TWP wires cannot be terminated at (spare) IC locations on the module so that the spare location is preserved.
- ECL and TTL ground wires cannot share the same termination point.
- Wires added to SMT components must follow the formation of the lead. Insulation must be positioned at the board and the stripped portion of the wire must follow the lead upward.
- Wires are not allowed to run over other components.
- Excess epoxy must NOT contact adjacent SMT or intrusive leads and MUST BE AVOIDED. Major physical damage may occur during component removal.

23.3 PROCESS DOCUMENTATION

For a complete process description, vendor and ordering information, equipment set up and operating procedure, a document will be provided later.

23.4 SPECIAL MATERIALS, TOOLS, AND EQUIPMENT

Twisted-pair wire cutter	47-00100-01 from EPE, Manchester, NH
TTL ONLY	... 30 AWG (Kynar)
REPAIR (black and white) TWP	Twisted pair wire No. 91-07720-09
Black = ground	
White = signal	
Yellow = single	No. 91-05740-44
REWORK (red and white) TWP	Twisted-pair wire No. 91-07720-29
Red = ground	
White = signal	
Green = single	No. 91-05740-55
ECL ONLY	... 30 AWG (FEP)
Repair (red and green)	Twisted-pair wire
Blue jacket	No. 17-00234-02
Red = signal	
Green = ground	
White = single	No. 91-05740-99
REWORK Wire (red and green)	Twisted-pair wire
Orange jacket	No. 17-0023401
Red = signal	
Green = ground	
Orange = single	No. 91-05740-55
POWER ETCH: 24 AWG	
Repair and Rework	
+5.0V red	No. 91-07688-22
-2.0V gray	No. 91-07688-88
-5.2V violet	No. 91-07688-77
Return black	No. 91-07688-00
Soldering iron	METCAL Sta Temp
Stereo microscope	Meiji, Wild, Parco, or equivalent
Continuity checker	Contact East (zero beeper)
Solder	63/37 Solder wire
Flux	RMA Type Alpha 611 F
Solvent	111-Trichlorethane or site-specified alternative, (Alpha 565) Freon TE-35 Solvent
Adhesive	Loctite black max or HV black max

23.5 LIMITATIONS

The manual tack soldering process for repairing a damaged etch run / connection on a printed wiring board is limited to etch lines larger than 0.008 inch (0.203 mm) in width only. For etch lines 0.008 inch (0.203 mm) and smaller welding Kovar wire is the only recommended method of repair at this time.

23.6 EVALUATION

Visual examination under a microscope at 10X and electrical testing are required. Refer to *DEC STD 176-0 Printed Wiring Board Acceptance Criteria* and *DEC STD 116-0 Workmanship Standards Manual* for acceptable and non-acceptable conditions.

CAUTION

Operator training, properly designed soldering irons, clean surfaces, and a controlled process all play a vital role in the success of this process. Therefore, understanding each variable is absolutely necessary. Extreme care must be taken to avoid overheating the reworked area, or internal board and component damage will occur.

23.7 TRAINING AND SUPPORT

Training and support is available through the TRG Training Group, Field Service Module Repair / Training Group in Andover, MA (DAS), Nijmegen, The Netherlands (JGO), and the Training Department, Salem, NH (NIO).

APPENDIX A MODIFICATION AND REPAIR PROCEDURES

This appendix provides procedures (by number), a description of the procedures, a repair illustration, levels of repair, and verification techniques as they appear in the repair document *Suggested Guide Lines for Modification, Rework, and Repair of Printed Boards and Assemblies*, IPC-R-700C.

NOTE

The following pages of this appendix are not available as soft copy. To view these pages, order hard copy from Standards and Methods Control.

APPENDIX B 50-MIL SMT ALTERNATE EQUIPMENT MATRIX

NOTE

This matrix is for internal use only and is not recommended for distribution outside Digital

Table 8: 50-Mil SMT Alternate Equipment Matrix

Features	Air-Vac DRS-21	*FARCO FP-120	LVSMT2.1 JGO EDSYN 1032	Gemtek PULSE-R	HART 200A	*M.E.S 6001B	*SRT-Sierra
Equipment Technology	Hot Air	Hot Bar	Hot Air	Pulsed A	Hot Air	Hot Air	Hot Air
Application	Rem/Rep	Replace	Replace	Rem/Rep	Rem/Rep	Rem/Rep	Rem /Rep
Recommended for Tech.	50-mil	50/25 GW	50-mil	50-mil	50-mil	50-mil	50/25
Component Placement	Yes	Yes	No	No	No	Yes	Yes
Micro Control Temp./Time	No	Yes	Temp. only	Yes	No	Yes	Yes
Automatic Cycling	No	Yes	No	Yes	No	Yes	Yes
Max. Board Size	14x22	15x18	20x20	?	20x20	14x16	16x20
Preheater	No	No	Yes	Yes	Yes	Yes	Yes
Head Orientation 0-90	Yes	No	N/A	Yes	Yes	Yes	Yes
Theta Adjustment	Manual	No	N/A	No	No	Yes	Yes
Dedicated Heads	Yes	Yes	N/A	Baffle	Baffle	Yes	Yes
Table Rotation	No	Yes	N/A	No	No	No	No
Gross X-Y Positioning	Yes	Yes	N/A	Yes	Yes	Yes	Yes
Fine X-Y Positioning	Yes	Yes	N/A	No	No	Yes	Yes
Table Lock	Yes	Yes	Yes	?	Yes	Yes	Yes
Auto Z Axis Motion	No	Yes	N/A	No	No	Yes	Yes
Co-Planarity Compensation	No	Yes	N/A	No	No	No	No
Vac. Hold While Place	Yes	Yes	Yes	No	No	Yes	Yes
Vac. Hold to Remove	Yes	Yes	Yes	No	No	Yes	Yes
Epoxy-Bonded Removal	No	No	Yes	No	No	Yes	Yes
Adjacent Comp. Protected	Yes	Yes	Yes	Some	Some	Yes	Yes
Parameters Displayed	No	Yes	Yes	Yes	No	Some	Yes
Output Deg C and F	No	Yes	No	No ?	No	Yes	Yes
Emergency Stop	No	Yes	N/A	Yes	No	Yes	Yes

Table 8 (Cont.): 50-Mil SMT Alternate Equipment Matrix

Features	Air-Vac DRS-21	*FARCO FP-120	LVSMT2.1 JGO EDSYN 1032	Gemtek PULSE-R	HART 200A	*M.E.S 6001B	*SRT-Sierra
Remove / Replace Mode	No	Yes	N/A	No	No	Yes	Yes
Illuminated Work Area	Yes	Yes	Yes	Yes	No	Yes	Yes
Microscope	Yes	Yes	No	No	No	Yes	No
Video Monitor	No	Yes opt	No	No	No	No	Yes
Real Time Alignment	Yes	Yes	N/A	No	No	Yes	Yes
Skill Level (Dexterity)	Low	Low	Med	Med	Med	Low	Low
Skill (Equip-Operation)	Low	Med	Low	Low	Low	Low	Low
Pick from Carrier	Yes	Yes	No	No	No	Yes	Yes
Approx. Price (USD)	$ 11 K	$70 K	$5 K	$ 12 K	$ 2 K	$ 12 K	$ 25 K
Approved bY MPE	No	No	No	No	Yes	Yes	Pending
Supported by MPE	No	No	No	No	Yes	Yes	Yes
Population in Digital							
	5	4	1	3	13	12	7
	AYR	APO	JGO	BTO	ABO	ABO	DAS
	KLO	AYR		ENO	APO	ASO	KDC
	GAO	MLO		NIO	ASO	CXO	GAO
	MOO	NIO			KLO	DAS	UCF
	ZGO				DAS	GAO	WFO
					GAO	LTN	ABO
					HKO	JGO	PNO
					MLO	NIO	
					NIO	WFO	
					SGO		
					ZGO		
					TAO		
					WFO		

* Has been demonstrated to be capable of removing HPTP devices.

APPENDIX C REFERENCED DOCUMENTS

C.1 EL-Class Digital Documents

EL-Class Number	Document Title
EL-MF265-00	*Suggested Guide Lines for Modification, Rework and Repair of Printed Boards and Assemblies IPC-R-700C*
EL-00012-00	*DEC STD 012-0 Part Identification Standard*
EL-00030-00	*DEC STD 030-0 Module Manufacturing Standard - Introduction and General Information*
EL-00047-01	*DEC STD 047-1 Bar Code: Product and Shipping Carton/Container Labelling*
EL-00067-00	*DEC STD 067-0 Electrostatic Discharge - Sensitive Devices*
EL-00116-00	*DEC STD 116-0 Workmanship Standards Manual - Introduction*
EL-00119-00	*DEC STD 119-0 Digital Product Safety - Introduction and General Requirements*
EL-00140-00	*DEC STD 140-0 Documentation, Data, and Release Requirements for Printed-Wiring Boards, Modules, and Backplanes - Introduction*
EL-00176-00	*DEC STD 176-0 Printed-Wiring Board Acceptance Criteria*
EL-00176-01	*DEC STD 176-1 Printed-Wiring Board Repair Criteria*
EL-MF413-00	*Logpoint Operator's Manual*
EL-MF417-01	*Surface Mount Technology Reference Manual - 2 Volume Set*
EL-MF422-00	*Automated Etch Cutter Operator's Manual*
76-65330-00	*Airvac Module Rework System - Process Operator Procedure*
76-65334-00	*Pace Desoldering System - Process Operator Procedure*
76-65372-00	*Inner Layer Shorts Rework Procedure*
EL-FS266-00	*Printed-Wiring Board (PWB) Gold Contact Cleaning Process*
EL-MF299-00	*Printed-Circuit Boards/Modules: Cleaning Process Contamination*
EL-MF362-00	*Etch Repair Procedures*
EL-MF412-00	*Hart (Hot Air Repair Terminal) 100 Rework System Operational Procedure*
EL-MF502-00	*Soldapak Solder Repair Workstation*

Use VTX SMC to order copies of EL-class documents from Standards and Methods Control. Send distribution questions to JOKUR::SMC or call DTN: 234-4423.

C.2 Other Digital Documents

Document Number	Document Title
A-AM-MEYELET-00-JG00	*Mark Eyelet Remover Operator's Manual*
A-AS-MSLECS-00-JG00	*MSLECS Software Installation Manual*
A-ME-VLSGLOS-00-JG00	*VLS Glossary of Terms*

Document Number	Document Title
A-ME-VLSUSER-00-JG00	*VLS User Manual*
A-PG-AUTOMIX-00-JG00	*EC83 Automix Process Guide*
A-PG-MEYELET-00-JG00	*Mark Eyelet Removal Process Guide*
A-PG-MSLECUT-00-JG00	*Multisignal Layer Etch Cutter Process Guide*
A-PG-PCBRM-10-JG00	*ZEVAC (De) Solder Process Guide*
A-PG-VLSILR-00-JG00	*VAX Layout System Inner Layer Equipment Control System Process Guide*
A-RE-MSLECS-00-JG00	*Multisignal Layer Equipment Control System Manual*
A-RE-MSLPLMS-00-JG00	*Multisignal Layer Pattern Layer Management System Manual*
A-RE-VLSILR-00-JG00	*VLS ILR Inner Layer Etch Repair Manual*
A-RE-VLSXYZ-00-JG00	*VLS XYZ Inner Layer Etch Repair Manual*
A-TP-MSLECUT-00-JG01	*MSLEC Rework Operator Procedure*
A-TP-PCBRM-10-JG00	*Generic Machine Maintenance Procedure*

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